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GALL APHIDS OF THE ELM.

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BULLETIN No. 181.

GALL APHIDS OF THE ELM.*

EDITH M. PATCH.

INTRODUCTION.

The study of this little group of elm aphids involves various problems, certain of which may be outlined here, as they add an interest to the species concerned.

Colopha ulmicola is considered by some the same as *Colopha compressa* of Europe. Even if this be the case, I have chosen to retain the American name for this species because it seems discreet to be entirely sure of the relations of this insect in one country before getting it involved with European problems.

So far as the literature is concerned the cockscomb gall in America has been so constantly associated with *Colopha ulmicola* that it was with considerable surprise that I found that the species issuing from the cockscomb gall in Maine in 1909 was not a *Colopha* but a *Tetraneura*. This cockscomb *Tetraneura* was, it seems, first taken by that most excellent observer Mr. Pergande years ago and in a correspondence with Mr. Monell received the name of *Tetraneura colophoidea* Monell mss. This species was described and figured under the name of *Tetraneura ulmi* (by error) by Mr. Sanborn,† but the name of *colophoidea* never escaped manuscript except in a paper "Upon the Aphis-feeding Species of Aphelinus" by Doctor Howard,‡ where it was merely mentioned.

The differences between *T. colophoidea* and *C. ulmicola* except for the venation are perhaps not such as would definitely

*Papers from the Maine Agricultural Experiment Station: Entomology No. 43.

†Kansas Aphid, page 23.

‡Ent. News, October 1908, p. 365.

separate these species, but as the venation runs constant in certain large collections it seems expedient to consider them as distinct unless future study shall show them to be dimorphic forms of the same species.

There can be no doubt that *Tetraneura colophoidea* is the elm gall form of *graminis* (on grass). Similarly there seems no longer any reason to hold *Colopha eragrostidis* (on grass) distinct from *ulmicola* of the elm.

Tetraneura ulmisacculi is described as a new species. It may prove to be a European species. It accords fairly well with Buckton's* characterization of *Tetraneura ulmi* both as to gall and insect. It does not accord with Lichtenstein's characterization of *ulmi*† nor *alba*.† The gall would preclude it from *rubra*, and as the European literature is not entirely clear for the species of *Tetraneura* it seems expedient to consider *ulmisacculi* as distinct from European species unless it can be definitely shown to be the same.

Tetraneura ulmi has been several times recorded for America but, except for some introduced specimens‡ which died out after the first year, there is no reason for considering these records as authentic for that species.

Schizoneura americana is by some considered the same as the European *Schizoneura ulmi*. If not the same it is certainly very closely allied. The fate of the migrants of this species has never been clearly followed. I find no recognizable constant differences between *americana* of the elm leaf curl and *rileyi* of the elm trunk and branch, and consider them possibly to be the same species. Biological proof of this is lacking.

The gall of *Pemphigus ulmifusus* was described by Walsh 40 years ago but except for a few words and comment at that time the insect was never characterized at all until it was described and figured from a specimen with freak venation as *Schizoneura* sp.§ in 1904.

The present bulletin indicates the following unsolved or partly solved problems for the gall aphids of the elm.

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*British Aphides.

†Les Pucerons des Ormeaux.

‡Monell, Can. Ent. Vol. 14, p. 16.

§Sanborn, Kansas Aphid, p. 28 and Plate VI, fig. 41.

1. The fate of the migrants of *Schizoneura americana*, the relation of this species to *rileyi*.

2. The complete life cycle of *Tetraneura graminis*.

3. The complete life cycle of *Colopha ulmicola*.

4. The relation of *Colopha ulmicola* and *Tetraneura* (*colophoidea*) *graminis* whether distinct species or dimorphic forms of the same.

5. The fate of the migrants of *Pemphigus ulmifusus*, and alternate host.

6. The fate of the migrants of *Tetraneura ulmisacculi* and alternate host.

7. The relation of the American species to the corresponding European species.

It is with some hesitation that I present this group of aphids with so much still not ascertained concerning them. Yet the well-nigh hopeless mixups in the records of these species would need to be straightened if possible.

This initial step I have earnestly attempted. The previously existing records, in many instances entirely unrelated as they stand, are correlated in this present paper so that they are presented as a unit (of a scrapbook nature it is true) in order that certain previous errors need not be repeated. The original descriptions of all the species have been quoted verbatim, as these are for the most part no longer available and a reference to them is necessary. Some entirely new data, for the most part slight, I have been able to add to each of the old species considered, but the paper is very largely compiled as will be seen by the liberal quantity of quotation marks.

Even so much order in the existing chaotic records of these few species as is here given would have been impossible except for the generous aid which I have received. In this connection I wish especially to thank Mr. J. T. Monell, who has gone carefully over the *Colopha-Tetraneura* situation so familiar to him, and sent me profuse notes and extracts and lent me aphid mounts most valuable for study, and I wish also cordially to thank Professor Oestlund, Mr. F. A. Sirrine and Mr. J. J. Davis, who have given me specimens and other aid most serviceable in the present study.

COLOPHA ULMICOLA

Byrsocrypta ulmicola Fitch.
Thelaxes ulmicola Walsh.
Pemphigus ulmicola Packard.
Pemphigus ulmicola Smith.
Colopha ulmicola Monell.
Glyphina ulmicola Thomas.
Colopha compressa (Koch) Lichtenstein and Cholodkovsky et al.
Colopha eragrostidis Middleton.

In spite of the fact that this species is recorded by many and from many localities, very few original observations have been published since the Riley-Monell paper. From the character of most of the records of *Colopha ulmicola* it is quite impossible to tell whether they refer to *ulmicola* or *colophoidea*. Probably a verbatim quotation of the more significant accounts would be a convenience for the purposes of this bulletin,—that is to bring together what is known concerning the gall aphids of the elm for America.

Fitch's characterization (1858) is reproduced entire as follows:

"347. Elm Gall-louse, *Byrsocrypta Ulmicola,* new species (*Homoptera. Aphidae.*)

"In June, an excrescence or follicle like a cock's comb, arising abruptly from the upper surface of the leaf, usually about an inch long and a quarter of an inch high, compressed and its sides wrinkled perpendicularly and its summit irregularly gashed and toothed, of a paler green color than the leaf and more or less red on the side exposed to the sun; opening on the under side of the leaf by a long slit-like orifice; inside wrinkled perpendicularly into deep plaits and occupied by one female and a number of her young, some of which are often strolling outside upon the under surface of the leaf, minute oval yellowish white lice 0.02 long, with blackish legs, the female more or less coated with white meal on her back, 0.07 long, oval and pale yellow with blacklish legs and antennae. Though I have not yet met with winged individuals, they in all probability pertain to the genus to which I have referred this species above. The galls may frequently be noticed on elm leaves. By the middle of summer they become tenantless, dry and hard and of a blackish brown color."

Walsh's (1862) description of the insect reads:

"*Thelaxes ulmicola* Fitch. New imago.—Black, more or less pruinose. Legs with the base of the femora and of the tibiae sometimes pale.

Wings hyaline; costa to the base of the stigma very pale fuscous, the stigma a little darker; veins fuscous, the 3rd discoidal hyaline halfway from its base to the fork; hind wings with the veins subhyaline. Length to tip of wings .05—.07 inch.

"Nine specimens. The antennae do not quite attain the origin of the first discoidal when the wings are expanded, and the stigma is twice as long as wide and hunched both anteriorly and posteriorly, its tips moderately acute. Occurs in elm-leaf galls, which are well described by Fitch (loc. cit.)."

Riley in the Riley-Monell paper gives the following discussion of *Colopha ulmicola* which is reproduced entire:

"COLOPHA* ULMICOLA (Fitch).

"(Forming cock's-comb-like galls (Fig. 129 a) on the upper surface of the leaves of *Ulmus americana,* the galls appearing with the opening of the leaves, and turning brown and black in late summer.)

"Another very common gall, which may be called the Cock's-comb Elm Gall (*ulmi-ulmicola*) is also found on the White Elm, and particularly as in the case of the previous gall, on young trees. It was well described by Fitch† as an excrescence or follicle like a cock's comb, arising abruptly on the upper side of the leaves, usually one inch long and ¼ of an inch high, compressed and its sides wrinkled perpendicularly and its summit irregularly gashed and toothed; of a paler green color than the

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"*The bibliography of this species very well illustrates the confusion that too often surrounds the proper determination, not only of insects of this family, but of all orders. It is due to three causes, not easily removed: 1st, the miserably insufficient nature of the earlier descriptions and definitions; 2nd, the isolation of the earlier English entomologists from those of the continent, and the dual nomenclature that has arisen from independent work; 3rd, the want of a common ground for generic characterization. Walsh referred the species to *Thelaxes,* which has, however, 5-jointed antennae. *Vacuna,* Heyden, is synonymous with *Thelaxes,* though Walker would restrict the former to *alni,* Schrank, and the latter to *dryophila,* Schrank ("The Zoologist", London, February 1870, p. 2001), without pointing out generic differences, as the want of a fork in the cubital vein in Koch's figure is clearly an error of the artist. Mr. Monell founded the genus *Colopha* for *ulmicola* on the fact that the antennae of the winged female are 6-jointed. Such a difference can hardly have generic value when we find *ulmicola* occasionally with but 5 antennal joints, and (if Huxley is correct in his determination) *dryophila* sometimes with six (Trans. Linn. Soc. xxii, pp. 203, 234). But, taken in connection with the fact that *ulmicola* is a flocculent species, the true female producing but one large egg, while *dryophila* is without flocculence, the female (according to Huxley) laying many eggs, *Colopha,* considering *ulmicola* as a type, may be accepted as a good genus."

†Fitch Report on the Noxious Insects of N. Y. 347.

leaf and more or less red on the side exposed to the sun; opening on the under side of the leaf by a long slit-like orifice; inside wrinkled perpendicularly into deep plates. The gall is always found between two of the branching parallel veins, and those between which it grows are generally drawn closer together than the rest. The corrugations and roughness, so characteristic of this gall, evidently result from the lesser susceptibility of the minute transverse veins to swell, compared with the more succulent tissue of the leaf. There is always a certain hoariness around the mouth of the gall below, while the base of the upper part is always contracted and compressed.

"Biological.

"The impregnated egg of this species is also to be found during the winter in exactly the same sheltered situations, in and under the bark of the White Elm, as that of *Schizoneura americana*. It is almost always sheltered by the dry and somewhat wrinkled skin of the true female, being seldom extruded, but occupying the whole of the body (Fig. 129 *b*). Occasionally the mother skin is more or less freed. The young stem-mothers hatch from the winter egg about the same time, and are minute dark olive-brown specks, just visible to the unaided eye, and quite active during pleasant weather, crawling nimbly about over the tree, till they reach a tender leaf that is just unfolding, when they also settle upon the under surface, and begin to feed on and fret the same. They doubtless insert their beaks in various portions of the buds or expanding leaves ere settling, since, before the gall begins to form, the little architect has generally obtained twice the size it had when first hatched. By the middle of April, in the latitude of Saint Louis, the galls generally begin to show, at first as slight elongate ridges on the upper surface, with corresponding closed depressions on the lower surface. Upon drawing apart the lips of the wrinkle beneath, at this stage of the growth of the gall, the stem-mother, who still retains her glossy olive-brown appearance, is seen constantly running back and forth in the cavity, and inflicting rapid punctures with her beak, the inner surface of her dwelling being smooth and glossy, with a slightly blistered appearance, in contrast with the normal, more rough and pubescent texture of the under surface of the leaf. The development of the gall is very rapid, and, with favorable weather, the top part begins to bulge so as to give the contracted appearance of the base, and the tooth-like prominences begin to appear by the third day. The inmate likewise grows apace. After the first molt, she soon becomes more pyriform and paler, with transverse rows of powdery secretion. She is less active, but still marches about, incessantly fretting the surface with her short, stout beak. A second molt takes place, and by the time the gall has fully developed, or about two weeks from the time it commenced forming, the process of reproduction commences, and continues for two or three weeks, until the stem-mother is exhausted, and the gall is absolutely crowded with this second generation in all stages of growth. The lice are more or less covered and interspersed with the mealy or cottony

excretion, and with the various-sized globules of gummy liquid, which is sometimes so abundant that it will fall upon the ground like a shower of milky fluid, whenever badly infested trees are shaken. The insects comprising this second generation, or the immediate issue from the stem-mother, thus born within the habitation which she had built up, are similar to their parent but somewhat larger at the moment of birth than she was, and of a paler olive-green color. They are quite active within the gall, exploring its concavities, and obtaining their nourishment through its walls. After the second molt, they attain the pupa state, (Fig. 129, *d*), and in due time become winged. There is but one generation produced within the gall—a generation, however, that becomes very numerous under favorable conditions. They all become winged, and in this respect the species differs essentially from *Schizoneura americana* as we have already seen. The winged lice carry their wings flat on the back while in the gall, but deflexed afterward. They issue from the slit on the lower surface of the leaf, which opens for their exit about the time they become fledged. They are all females, and give birth, in the course of a day or so, to upward of a dozen young, which, when first born, are enclosed in the usual delicate egg-like covering already alluded to, and which look like their immediate parent at a corresponding state of existence, except that their antennae have five subequal joints, and the promuscis reaches to the hind coxae (Fig. 129, *c*).

"So far I have been able to trace the history of the species with absolute certainty, watching it for several years, and proving, by extracting the stem-mother soon after she had commenced reproducing, that the second generation, *i. e.*, her immediate progeny, all become winged, the species agreeing in this respect with the gall-making species of *Phylloxera* that affect the Hickory. There is, however, a link yet wanting in our knowledge of the history of this species, between this third generation and the mouthless sexual individuals, the females of which so often perish while yet covering their solitary winter eggs. I have not been able to prove absolutely that there are two broods of the gall-making female, and my observations all tend to the conclusion that no galls are formed except by the stem-mother that hatches from the impregnated egg. I have never succeeded in obtaining galls either by enclosing the winged females in muslin bags tied on the living trees, or by similarly enclosing her immediate progeny, though I have succeeded in obtaining, without any difficulty, an abundance of galls by so enclosing the stem-mother. Moreover, all such succulent galls as this one are produced on the tender young leaves only, and I have failed to find them on any but those which develop early in the season. It is true that we may frequently find the galls quite fresh, and containing larvae, pupae, and winged insects as late as the first week in July, and these late galls, as well as the insects within them, are generally more yellowish than those found earlier in the year; but a careful study of the structure of the inmates shows them to be identical with those found in the earlier galls, and these late galls are, from present knowledge, to be attributed to the work of late hatching and late developing stem-mothers rather than to

work of the third generation. I am inclined to think that this third generation will be found to have a different habit, possibly feeding upon some other part of the tree, without forming galls, and producing in time the true sexual individuals, something as in the case of the seventh generation of *S. americana*. At all events, the true female (Fig. 129, *b*), with the solitary egg, is to be found about the trunk of the tree, as already described.

"DESCRIPTIVE.

"COLOPHA ULMICOLA.

"*Byrsocrypta ulmicola,* Fitch 4th (sic.)* N. Y. Rep. 1858, p. 63, (§ 347).—*Thelaxes ulmicola,* Walsh. Proc. Ent. Soc. Phil. vol. i, p. 305, 1862; American Entomologist, Vol. i, p. 108, 1869.—*Colopha ulmicola,* Monell, Canadian Entomologist, vol. ix, p. 102, 1877.

"*Impregnated or winter egg* (Fig. 129, *b*).—Length 0.38 mm, perfectly ovoid, shining olivaceous, inclining to brown, with no particular sculpture.

"*First generation, or stem-mother.*—0.4 mm. long when hatched. Antennae 4-jointed, joints subequal in length and thickness, but with the bases of hairs rather strong. Promuscis very short, reaching only to middle coxae or a little beyond. Upper tarsal hairs globate at tip and as long as tarsus. Smooth, dark olive-brown in color with black members. After first molt, the beak is still relatively shorter, as also the tarsal hairs; the color is paler, but the members are still black. She measures 1 mm. in length when beginning to bear, and the third joint of antennae is then somewhat clavate (Fig. 129, *g*), and as long as joints 1 and 2 together; the 4th narrower, as long as 3d, and rather truncate at tip, with two rather conspicuous piliferous prominences. Color translucent yellowish-green, often inclining to purple.

"*Second generation.*—0.4 mm. long when born (Fig. 129, *c*); nearly five times as long as wide; the antennae (Fig. 129, *h*) short and 5-jointed, the joints subequal in length, the 3d shortest and narrowest, the 5th swollen and sub-fusiform, with rather strong bulbs at the base of the hairs. Promuscis reaching to hind coxae. Distinct globate tips to the four tarsal hairs. Color pale olive-green, with black members and a dusky stripe on the notum. *Pupa* (Fig. 129, *d*) with antennae smooth, 6-jointed, joints subequal in thickness, joint 4 only as long as 2; 5 and 6 each twice as long; 3 four times as long. Color dingy orange, with a paler band around the thorax, embracing the wing-pads, and reminding one, on this account, of the pupa of *Phylloxera. Winged female* (Fig. 129, *e*): Average expanse 3.7 mm.; the form of body more as in *Phylloxera,* the abdomen tapering and narrower than the thorax, bearing from ten to twenty pseud-ova. Blackish, with an olive green tint, the abdomen and under surface yellowish-green in the fresher individuals. Antennae (Fig. 129, *f*) reaching only to insertion of front wings, 6-jointed; joints 4, 5, and 6 subequal, and together equal to 3 in length.

*5th.

(Three specimens examined have joints 4 and 5 very imperfectly separated, causing the antennae to appear as 5-jointed). Wings as described by Walsh, the stigma being well rounded and pale. (In three specimens examined, the third discoidal of the front wing is simple and precisely as in *Pemphigus;* in one specimen, the first discoidal is wanting on both front wings, and in another the fork of the third discoidal is wanting on the left one). Basal joint of tarsus rather short; tarsal claws only moderately strong.

"*Third generation.*—The young from the winged female, after being freed from the pellicle in which they were born, have stout five-jointed antennae, the joints subequal; stout but short promuscis reaching to hind coxae; rather large compound eyes. Proportions and shape of young *Phylloxera.*

"*True female:* Legs short and the basal joint of tarsus rudimentary; antennae short, four-jointed, smooth, joints subequal, the third somewhat longest. Mouth rudimentary. Described from skins surrounding impregnated egg. Males unknown."

Thomas (1879) gives for this species besides a systematic discussion, the following characterization:

"*Glyphina ulmicola.* Fitch. The Aphis of the Elm-leaf Cockscomb gall.

"This species forms the cone-shaped galls, so common on the upper side of the leaves of young white elms. These galls, which are often an inch or more in length, vary in height, from one to three-quarters of an inch; they are compressed and grooved on the sides, and perpendicular, showing tooth-like, conical projections at the top: opening by a long slit on the under side. The inside is wrinkled perpendicularly into deep plaits or folds, and occupied by one female and her progeny, some of which may often be seen strolling out on the under side of the leaf.

"My examinations of these insects show the characters of the species to be as follows:

"*Winged individual.*—Length of body about .05 inch, to the tip of the closed wings .08 inch, thorax black; the abdomen dull black or greenish black above; paler, obscure green beneath; slightly pruinose. Antennae very short, scarcely reaching beyond the insertion of the forewings; first and second joint very short; third much the longest, about equal in length to the three following taken together, fifth and sixth about equal, all except the basal joints transversely corrugated. Wings transparent, resting somewhat flatly on the abdomen while in the gall, but after the specimens have been removed for a while, will assume the usual erect position, the costal and sub-costal veins dark; the latter robust and undulating; stigma prominent; the first and second discoidal veins are close together; the third obsolete at base, emits the fork about midway its length (counting to the imaginary point of insertion). No honey-tubes; the abdomen expanding near the tip.

"The *wingless individuals* are very short, broadly ovate, and very convex; olive green, covered slightly with a white powder; antennae and legs very short."

As stated under the discussions of *colophoidea* it is not certain whether *ulmicola* and *colophoidea* are distinct species or dimorphic forms of the same species. Recognizing the danger of making a composite species on insufficient basis, I have considered them distinct and think it expedient to do so unless they are definitely proven to be the same, although I find no character except the venation to separate them, M being branched for *ulmicola* and simple for *colophoidea*.

Concerning the stability of the branched M for *ulmicola* the following statements are of interest:

Walsh, who first described the winged form, put the insect in *Thelaxes* (M branched) and figured the *Thelaxes* wing with a branched M. He says, "Dr. Fitch had not seen the winged insect, of which I have obtained many specimens." Mr. Monell erected *Colopha* (M branched) for this insect. In a letter to Mr. J. J. Davis, December, 1908, Mr. Monell wrote: "I have not seen the *Colopha ulmicola* for some years but have examined hundreds of specimens and find venation very constant. I have also examined hundreds of *Tetraneura colophoidea* and find its venation always constant." In a letter to me, February 3, 1910, Mr. Monell wrote: "Riley gave a whole summer to the insect and published the results of his work in the Riley and Monell paper. All this time the *Tetraneura* was unknown. Riley's collecting point was, when he lived about 5 miles west of Saint Louis, at Webster."

Riley, who must have seen many winged specimens, records (1879) only 5 specimens departing from *Colopha* venation. "Wings as described by Walsh, the stigma being well rounded and pale. (In three specimens examined, the third discoidal (M) of the front wing is simple and precisely as in *Pemphigus;* in one specimen, the first discoidal (A) is wanting on both front wings, and in another the fork of third discoidal is wanting on the left one."

Thomas (III Report) describes M branched as did Walsh, "the third (discoidal) obsolete at base, emits the fork almost midway its length (counting to the imaginary point of insertion)."

Cowen (1895) records in a preliminary list of the Hemiptera of Colorado, as though it was exceptional, "*Colopha ulmi-*

cola Fitch. Fort Collins, July 8th, in 'cockscomb' galls on *Ulmus americana*. Five of the specimens examined have the cubital (M) of fore wings simple."

Mr. Sirrine's letter (Feb. 28, 1910) states "the most constant distinction" (i. e., between *ulmicola* and *colophoidea*) "is the forking of the third discoidal."

We have then, Monell, Riley, Sirrine, Thomas, Walsh (certainly competent observers!) all familiar with the species, giving the venation with M branched and Cowen recording 5 specimens with M simple as though they were exceptional.

My personal acquaintance with *Colopha ulmicola* is chiefly limited to the following material:

1. A slide lent me by Mr. Monell collected July 2, 1876, at St. Louis. The slide was labeled *"Thelaxes ulmicola* 157." This material was collected before Riley's paper appeared and was, Mr. Monell states, "certainly either type or co-type of the genus *Colopha*." There are 4 winged specimens on the slide, the 8 fore wings of which have M branched. Venation perfectly regular.

2. A slide lent me by Mr. J. J. Davis on which were mounted 16 winged specimens collected at LeRoy, Illinois, July 10, 1907. Of these 15 specimens have M of both fore wings branched, and the other has M simple in one wing and an indication of the distal tip of a branch in the other wing. Of the 16 specimens 4 had irregular venation in varying degrees.

3. A slide lent me from the Thomas collection. It contained 1 winged specimen. M of both wings branched, Cu and A of one wing also branched, and a slight stub branching from Cu on the other.

4. A vial with several galls, winged individuals and pupæ lent me from the Thomas Collection. Vial labeled merely "36."

The antennæ of the specimens lent me by Mr. Monell have III, 0.16 mm.; IV, 0.05 mm.; V, 0.06 mm.; VI, 0.065 mm.; approximately. Camera lucida sketch of one of these antenna is given in Fig. 176. The wing expanse is 3.7 mm. The antennæ of the specimens lent me by Mr. Davis have III, 0.19 mm.; IV, 0.05 mm.-0.06 mm.; V, 0.07-0.075 mm.; VI, 0.07 mm.-0.09 mm. A camera lucida sketch of one of these is given in Fig. 178. The wing expanse is 3.6 mm.

5. Slides lent me by Mr. Sirrine containing stem mother, pupæ, and 12 winged forms from cockscomb galls on Cork Elm, I. A. C., 7-4-'93. (Figs. 131, 136, 179).

Besides the foregoing gall material I have examined as given in the following record, the grass form, the winged individuals of which show no distinguishing characters to separate them from the migrants from the gall.

6. *Colopha eragrostidis.* A co-type slide lent me by Mr. Monell, to whom it was given by Miss Middleton in 1877. Two specimens on slide, both of which had M as typical for *ulmicola* though one Cu was abnormal in one specimen. Antennæ as in *ulmicola.*

7. *Colopha* (*eragrostidis*) *ulmicola.* Slides lent me by Mr. Sirrine. Material comprises 1 apt. vivip. form and pupa from roots, several pupæ and 9 winged forms from blades of *Eragrostidis* sp. Slides bear the dates of 9-28-'92, 10-8-'92, 9-9-'93, 9-20-'93. Collections made in part at Squaw Creek. Wing and antennal characters as in co-type slide of *eragrostidis* and as in *ulmicola.* (Figs. 130, 132, 180).

The October collection evidence of Osborn and Sirrine, the statement of Riley in regard to the identity of *ulmicola* and *eragrostidis* and the structural evidence of the mounted specimens from the various sources at hand during the present study are conclusive enough, I believe, to make *eragrostidis* definitely a synonym of *ulmicola.* For the important experimental evidence recorded in letter of Mr. Sirrine the reader is referred to page — of this bulletin.

Following is given the original description of *eragrostidis* by Miss Middleton which was printed in 1878 in Bulletin No. 2 of the Illinois State Laboratory of Natural History:

"*Colopha eragrostidis,* new sp.

"*Winged individual.*—General color reddish-brown; head black; prothorax yellowish, rest of the thorax and abdomen reddish brown; veins of the wings dark; stigma pale brown.

"*Wings,* when first seen horizontal, but becoming erect, formed and veined as usual; the third vein in the anterior pair with only one fork and obsolete nearly half way to the base of the fork; the first and second veins approximate very closely at the base. Posterior pair with but one discoidal vein.

"*Antennae* six jointed, with the sutures between the third and fourth and between fifth and sixth transparent; first and second joints short; third about equal to the fourth, fifth and sixth united; the fourth and

fifth nearly equal in length; sixth very short, but little exceeding the first and second united. The antennae as compared with the body are very short, scarcely reaching to the base of the front wings; not tapering.

"*Wingless individual.*—Body covered with a cottony substance; beak short, not extending to the base of the second pair of legs. No honey-tubes. Length of the body .06 of an inch; to tip of wings .10 of an inch. (sic.)*

"This species was found September 1st, 1877, on the upper leaves and fruit stems of a species of grass (*Eragrostis poaeoides* var. *megastachya*), the blades of the grass folding over the insects.

"It is also found on some species of *Panicum*.

"This evidently belongs to Mr. J. Monell's new genus *Colopha*, as the third vein of the front wing is but once forked, the hind wings have but one discoidal vein, and the antennae are six-jointed."

Bibliography.

It is with some hesitancy that I attempt a bibliography for *ulmicola*. Mr. Monell (The Can. Ent. IX, page 103) refers to such bibliography of this species as appeared before 1877 as a "Comedy of Errors," and as Mr. Hunter's list (1901) contins eight errors (some minor) the cock's comb gall louse is still apparently a difficult species in a literary way. Eight or more authorities who have attempted references have added to the confusion. The following list is therefore offered somewhat timidily, though hopefully. The accounts which I have not personally seen are cited in ( ). For the accuracy of the others I am responsible.

1858 (Pub. 1859). Brysocrypta ulmicola Fitch. Fifth Report Ins. N. Y. Trans. N. Y. St. Agric. Soc. Vol. XVIII, p. 843, paragraph 347 (63rd page of 5th Report, paragraph 347). Original description of galls, stem-mother, and nymphs.

(1861. ——— ——— Osten Sacken, Stett. Ent. Zeit. *22*: 422).

1862. Thelaxes ulmicola Walsh, Proc. Ent. Soc. Phil. Vol. I. pp. 304, 305, original description of winged form. p. 297, Fig. V. and table.

(1866. ——— ——— Walsh, Pract. Ent. *1*: 114; *2*: 8.)

1869. Thelaxes ulmicola, Walsh and Riley. American Entomologist. Vol. I, p. 108. Description of insect and gall and Fig. 90 of gall. Also p. 224 mere mention.

1869. Thelaxes ulmicola, Packard. Guide: p. 523.

"Pemphigus ulmicola of Fitch" Packard. Guide: P. 524-525,

*So it stands in the original description but it is evident that these measurements were taken for the *winged* and not *wingless individual*.

with Fig. 525 (after Walsh and Riley) and brief quotation from Walsh and Riley, American Entomologist, Vol. I, p. 108.

(1874. ——— ——— Riley. N. Y. Tribune, July 22, p. 17).

1877. Colopha ulmicola (Fitch) Monell. Monell. Can. Ent. *9*: 102. Original description of genus and comments on bibliography.

(1877. Pemphigus ulmicola. Emily A. Smith. Shade Trees, indigenous shrubs and vines, and insects that affect them. Peoria, Ill.)

(1878. Brysocripta (Glyphina) ulmicola, Lintner. Country Gentl. July 18. *43*: 455. Brief account.)

1879. Colopha ulmicola, Riley. Bull. U. S. Geol. Surv. Vol. V. No. 1, pp. 9-13. Fig. 2, a-g. Biological and descriptive.

1879. Glyphina ulmicola Thomas. Ins. Ill., 8th Report (Thos. 3rd). pp. 142-144. Fig. 21 (after Riley), Fig. 22 (after Walsh and Riley, American Entomologist). Description, Systematic discussion. Comments on bibliography. Page 204-205 quotes Riley's (Bull. U. S. Geol. Surv. V.) description.

1880. Colopha ——— Lichtenstein. The American Entomologist. Vol. III. New Series Vol. I, No. 3, New York, March. "Interesting Notes from South France."

1881. Colopha ulmicola, Packard. U. S. Ent. Com. Bul. No. 7, p. 68. Quotes Fitch in part.

1882. Colopha compressa (Koch), Monell, Can. Ent. *14*: 15.

(1886. Glyphina (Colopha) ulmicola, Lintner. Country Gentl. Sept. 23. *51*: 713. Galls described, and synonyms and bibliography given).

(1886. (1888) Glyphina (Colopha) ulmicola, Lintner, 3rd Report 126-128, 151).

(1887. Glyphina (Colopha) ulmicola, Lintner, Country Gentl. June 23, *52*: 491. Brief notice).

1887. Colopha ulmicola, Oestlund Aph. Minn. pp. 25-26. Description and systematic discussion.

(1888. Colopha (Glyphina) ulmicola, Lintner. Country Gentl. June 28. *53*: 496. Galls on the 'weeping slippery elm' are described and identified as those of C. ulmicola Fitch).

1889. (1890). Colopha ulmicola, Perkins Ann. Rept. A. E. S. Vt. 3rd. pp. 162-163. Fig. 19 (after Riley).

(1890. Colopha ulmicola, Perkins 11th Rept. Vt. State Bd. of Agric).

1890. Colopha ulmicola, Packard Forest Ins. Fifth Rept. Ent. Comm. p. 227. Quotes Riley in part.

1892. Colopha ulmicola, Beutenmüller. Cat. of Gall Insects.

1892. Glyphina ulmicola, Osborn. Proc. Ia. Acad. Sci. Vol. I, pt. II, Cat. Hemip. of Iowa.

1893. Colopha ulmicola. Osborn and Sirrine. Iowa Acad. of Nat. Science, Dec. 28, (1892). Insect Life *5*: 237. An October collection. Resemblance between *ulmicola and eragrostidis* commented upon and identity suggested.

1893. Colopha ulmicola, Riley. Insect Life 5: 235. Footnote. *Ulmicola* considered identical with *eragrostidis*..

1895. Colopha ulmicola, Comstock. Manual p. 161. Brief description of gall.

1895. Colopha ulmicola, Cowen. Preliminary list of the Hemiptera of Colorado, p. 116.

1896. 1897. Colopha compressa, Cholodkovsky (Zool. Anz., 1896, No. 520, pp. 508-513, rev. in Zool. Centbl., 4 (1897), No. 26, pp. 918-919). *Colopha compressa* of Koch is regarded as identical with the American *Colopha ulmicola*. The intermediate generation of *Colopha compressa* was found on the roots of *Aira caespitosa*.

1896. Colopha ulmicola, Smith. Economic Entomology. p. 132. Fig. 96 (after Riley).

1897. *Cocks-comb Gall,* Harvey. Rept. Me. Agr. Exp. Sta. for 1897. p. 173, mere mention.

(1899. ——— ——— Sanderson. Amer. Gardening. 3 June).

(1899. ——— ——— Felt. Rural New Yorker. 18 July).

1899. Colopha ulmicola, Johnson Bull. Div. Ent. U. S. Dept. Agric. *20* (n. s.); 65 (Mentioned as injurious in Maryland).

1900. Colopha ulmicola, Lugger. 6th Annual Report of the Entomologist. p. 168. Fig. 135 (after Riley). Id. Bulletin No. 69. Minn. Agric Exp. Station.

1901. Colopha ulmicola, Hunter Aphid. of N. A., p. 80. Bibliography in part.

(1901. Colopha ulmicola, Bruner, Nebr. Farm).

1902. Colopha ulmicola, Cook. Galls and Insects Producing Them. Ohio Nat. Vol. II, No. 7, p. 265 and Fig. 13 a, b. Discussion of structure of gall.

1903. Colopha ulmicola, Cook. Galls and Insects Producing Them. Ohio Nat. Vol. III, No. 7, p. 425, and Fig. 50 a, b. Discussion of structure of gall.

1903. ——— ——— Saunders. So. Dak. Agr. Exp. Sta. Bull. 81. Description of Elm Coxcomb Gall. pp. 63-64.

1904. Colopha ulmicola, Beutenmüller. Amer. Mus. Jour. Vol. IV. No. 4. Insect gall number. 1904, p. 91, p. 123. Fig. 83.

1904. Colopha ulmicola, Cook. Galls and Insects Producing Them. The Ohio Naturalist. Vol. IV, No. 6.

1905. Colopha ulmicola, Cook. The Insect Galls of Indiana. (From the 29th Ann. Rept. of the Dept. of Geol. and Nat. Resources of Indiana. 1904, pp. 801-867), pp. 847, 848 and Fig. 40. Brief description of gall. Bibliography in part and photo of galled leaves.

1905. ——— ——— Washburn 10th Ann. Rept. of the State Ent. (Washburn 4th, pp. IV, V. Mention of gall and photograph Fig. 1).

1906. Colopha ulmicola, Kellogg American Insects. p. 180. Brief description of gall.

1906. Colopha ulmicola, Folsom. Entomology. Fig. 249. Photograph of galls on leaf. p. 255.

1906. Colopha ulmicola, Felt. Insects Affecting Park and Woodland Trees. N. Y. State Museum Memoir 8. pp. 172, 186-87, 247, 620, 633.

1878. *Colopha eragrostidis* Middleton, Bull. Ill. Lab. Nat. Hist. No. 2. p. 17. Original description.

1887. *Colopha eragrostidis,* Oestlund Aphid. Minn. p. 29. Listed for America.

1893 *Colopha eragrostidis,* Osborn and Sirrine, Proc. Ia. Acad. Sci. *1*: pt. 3, 100 (Insect Life 5: 237). Suggested identity with *ulmicola.*

1893. *Colopha eragrostidis,* Riley. Insect Life *5*: 235 foot note. Considered identical with *ulmicola.*

1901. *Colopha eragrostidis,* Hunter Aphid. of N. A. p. 80. Bibliography and host plants.

TETRANEURA GRAMINIS (COLOPHOIDEA)

Tetraneura graminis Monell.
Tetraneura colophoidea Monell mss.
Tetraneura ulmi Osborn-Sirrine. Not Linn.
Tetraneura ulmi Sanborn. Not Linn.
Tetraneura colophoidea Howard.
Tetraneura ulmicola Gillette.

(Producing a cockscomb-shaped gall on the dorsal side of leaf of *Ulmus americana.* Fig. 126).

Descriptive.

First generation,—apterous viviparous stem mother. Eyes in a group of three ocelli on each side of head. Head, thorax, and abdomen translucent, pale yellow and pulverulent. Head sometimes a little smoky. Antennæ, beak, and legs (femora, tibia, and tarsus) dusky. Beak short, not reaching second coxæ. Antenna 4-jointed (sometimes 5-jointed by a faint division of III). III about the length of I+II and about twice as long as IV. In the specimen measured, I, 0.05 mm.; II, 0.04 mm.; III, 0.1 mm.; IV, 0.05 mm. Total length of large individual, 1.57 mm. Color description from live mature specimens examined July 8, 1909, measurements from balsam mounts. At this date in some galls the stem mother was still plump, in others much shrunken. Habitat,—single stem mother with progeny in cockscomb gall on *Ulmus americana.* Figs. 172 and 173. Maine collection numbers aphid 23-09, aphid 57-09, aphid 65-09.

Apterous viviparous form not stem mother. Head and thorax white, abdomen greenish. Eyes, antennæ and legs dusky. Antenna 6-jointed. I, II about subequal; III, IV, V about subequal, each being shorter than II; VI about equal to IV+V and longer than II. I, 0.03 mm.; II, 0.035 mm.; III, 0.029 mm.; IV, 0.027 mm.; V, 0.025 mm.; VI, 0.055 mm. Beak short, not reaching second coxæ. Total length of body, 1.5 mm. This form when removed from the gall propelled itself with a humping motion by curling under the tip of the abdomen and using that as an aid in locomotion. Color description from live mature specimens taken July 14, 1909, measurements from balsam mounts. Habitat, 1 or 2 frequently found in cockscomb gall on *Ulmus americana* in company with stem mother and pupæ of *T. colophoidea.*

Described from 6 specimens. Figs. 133, 174. Maine collection number Aphid 65-09.

Second generation,—migrants. Abdomen and ventral body greenish black, abdomen pulverulent, antennæ, head, thorax and legs black. Wings as typical for *Tetraneura,*—M unbranched in fore wing and Cu wanting in the hind wing. Veins and stigma are dark. Wing expanse about 4 mm. Antennæ with IV, V, VI approximately subequal. III, 0.175-0.195 mm.; IV, 0.075-0.085 mm.; V, 0.065 mm.; VI, 0.055-0.063 mm. III with an average of 12 partial annulations. IV with an average of 6 partial annulations. V with an average of 4 partial annulations. VI comparatively smooth though with irregular annulations frequently present, especially at base of unguis. (Figs. 169, 170).

This generation while in the young nymphal stage are yellow and colored like stem mother except that the eyes are red. Pupæ about ready to molt have head, prothorax, and abdomen dark bluish black. Antennæ 6-jointed (Fig. 171). Antennæ, legs and thorax are much paler and the wing pads are a translucent smoky white. Eyes black. Color description from live specimens examined July 8, 1909. Habitat, developing in cockscomb gall on *Ulmus americana* and migrating from elm upon leaving gall. Maine collection numbers aphid 57-09, aphid 65-09.

———*? generation. Larvæ.* Beak reaching to 2nd coxæ. Antenna 5-jointed with V very uneven and ragged at tip. See

Figs. 143, 144, 145. Described from 3 balsam specimens of material collected by F. A. Sirrine, 9-30-'92. Habitat, roots of grass, *Leersia virginica.*

———*? generation.* "*T. graminis* n. sp. Head and thorax dusky, abdomen dusky or sometimes of a greenish or yellowish tinge. Antennæ dusky, the third joint as long as the three following taken together; joints four and five equal; apical joint a little over half as long as the preceding. Wings hyaline. Subcostal of the hind wing comparatively straight.

Length of body .08, to tip of wings .12 in.

On leaves of *Aira cæspitosa* and *Agrostis plumosa,* enveloped in a thick cotton-like secretion.

Sept.-Oct. St. Louis, Mo., Springfield, Mo., Neosho City, Mo."*

See Fig. 134. A slide lent by Mr. Monell labeled "43" contained a specimen collected October 11, 1876, has a wing expanse of 4.4 mm. and antennal measurements I, 0.035 mm.; II, 0.035 mm.; III, 0.2 mm.; IV, 0.07 mm.; V, 0.06 mm.; VI, 0.055 mm.

The *return migrants* (*sexuparæ*) on leaves of *Leersia virginica* and specimens alighted on bark of elm, lent me by Mr. Sirrine accords with material lent me by Mr. Monell.

The pupæ on *Leersia virginica* (Sirrine material) have a 6-jointed antenna with III about as long as IV+V. IV, V, and VI are subequal. This accords with the pupal antenna of *T. graminis* (*colophoidea.*)

———*? generation. True sexes.* Without beaks. Female: Antennæ 4-jointed with a peculiar thumb-like projection on IV (Fig. 181). Legs with long capitate hairs (Fig. 182). Length 0.55 mm. Male shorter; more slender. Described from balsam mounts lent by Mr. Sirrine of material taken on bark of *Ulmus americana,* I. A. C. 10-4-'92.

Biological.

A single stem mother occurs in each gall and her progeny up to the time of the migration (July 8-14, 1909, Orono, Maine) are about 70 in number, consisting in nymphs (destined to become winged); pupæ, and newly winged forms. At this time

*Can. Ent. Vol. XIV. Jan. 1882, p. 16. Original description quoted entire.

some of the stem mothers are still plump and actively producing, in which case very young nymphs occur in the gall together with the newly winged forms not yet migrated, while other stem mothers are much shrunken and no longer producing. On June 19, 1909, most of the stem mothers were in the last instar but not yet producing.

Besides the stem mothers and migrating progeny there are sometimes 1 or 2 apterous viviparous individuals in the gall. (Figs. 133, 174, 175). The counts I made of Maine material gave these at the rate of 2 for 13 galls. They were maturing at the same time as the older of the migrants,—as was shown by the embryos in their abdomens. What possible part these forms play in the life history of the species I am unable even to guess. There is the possibility that these are some distinct species of aphid which has crowded into the opening of the gall as guest. If so it is some species I have never taken in any other connection. It is certainly desirable that nymphs produced by this form be reared through to the winged stage.

The migrants after molting leave the gall through the opening slit on ventral leaf. Their immediate fate has not been followed but there is no doubt that they seek some species of grass on which to deposit their young. It is indeed *Tetraneura graminis* Monell which Mr. Monell has long considered to be the grass form of *Tetraneura colophoidea.**

From the Sirrine slides it seems likely that the nymphs live upon the grass roots and that the pupæ crawl up and settle upon the grass blades before molting.

The return migrants, according to the collection recorded by Osborn-Sirrine, like those of *Colopha ulmicola,* seek the bark of the elm in the fall and deposit the true sexes which produce the winter eggs. "Winged forms of *Tetraneura graminis* were found flying from *Leersia virginica* and at the same time winged specimens of *Tetraneura ulmi*" (here=*colophoidea*) "were observed alighting and hiding under rough bark of the elm; where afterwards the peculiar males and females of the latter were found as also the single egg of the female."*

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*This is the species suggested to be the same as *graminis* by Osborn-Sirrine (1893) but as it was listed by them under the name of *ulmi* this record has been somewhat confusing.

*Proc. Ia. Acad. Sci., Vol. I, Part 3, pp. 98-101.

At the time of preparation of this paper I have six slides of this species lent me by Mr. Sirrine. One slide is labeled *"Tetraneura ulmi,* winged adult, and pupa and stem mother. From cocks comb gall on *Ulmus americana.* I. A. C. 6-27-'93." The specimens accord with Maine specimens of *Tetraneura colophoidea,* and the winged forms accord with a slide of *T. graminis* lent me by Mr. Monell. The Sirrine material also comprises *Tetraneura graminis,* larvæ, pupæ, and winged adult collected from blades of grass, *Leersia virginica* and larvæ from roots of same. Also migrants which had alighted on the bark of *Ulmus americana* and their progeny, true males and females (see figures) and an egg. The collections from grass were labeled "I. A. C. 9-30-'92" and "I. A. C. 9-13-'93." The specimens collected from elm trunk are dated "I. A. C. 10-4-'92."

A careful consideration of the evidence at hand and the comparison of the identical material recorded by Osborn-Sirrine with Maine material of *colophoidea* and the comparison of it all with the Monell slide of *Tetraneura graminis* convince me that these are all the same species. The evidence of the return migration and the structural evidence certainly seems sufficient to establish their identity. Moreover the experimental evidence in the following letter gives interesting testimony.

RIVERHEAD, N. Y., March 14, 1910.

My Dear Miss Patch:—

Replying to your letter regarding the colonization of *Tetraneura* and *Colopha;* I succeeded in colonizing *Tetraneura* on *Leersia* and *Colopha* on *Eragrostis.* The transfers were made by transplanting the grasses to pots and growing same under lantern-globes in forcing house. As soon as the migrants in the galls showed winged specimens, the galls were placed on the pots under the jars allowing the migrants to find the host plants themselves. Galls containing *Tetraneura* were placed under jars containing *Leersia,* also under jars containing *Eragrostis.* Galls containing *Colopha* were treated in same way.

Unfortunately the larvae of the migrants were not carried to maturity in confinement, nor the number of summer broods on annuals determined. At the time I had class work and other field work to look after. Those who had charge of the forcing house neglected to ventilate one hot day and I found things cooked.

The two species were found in field at same time and frequently during the summer; but if you can carry them through the summer in confinement and determine number of broods, do so.

Sincerely yours,
F. A. SIRRINE.

Discussion.

The introduction of the gall form of this species is of peculiar interest. Perhaps no aphid gall is more generally familiar than the cockscomb gall of the elm. This gall has always been associated in our literature only with *ulmicola*. It was, therefore, with considerable surprise that I found that the species emerging from the cockscomb gall in Maine in 1909 was not a *Colopha* but a true *Tetraneura* by virtue of its venation—M being constantly unbranched. After examining 2,000 wings (1,997 of which had M simple) to be sure of a safe basis, I found I was confronted with the dilemma, either two species of aphid occur in similar cockscomb galls on the elm or *Colopha ulmicola* is dimorphic. As there are no well established specific characters sufficient to separate *ulmicola* and *colophoidea* except the venation, there is as yet no positive proof as to which is the case. But as both *ulmicola* and *colophoidea* show constant venation in certain large collections, the former with M branched and the latter with M simple, it is certainly desirable to treat them as distinct for the present. Especially is this true because *Tetraneura graminis* is shown* to be the grass form of *Tetraneura colophoidea* and a sweeping amalgamation of four species is not desirable without very definite biological proof.

Tetraneura colophoidea has a manuscript history of no slight interest as is indicated in the following extracts from Mr. Monell's recent letters:

"*Tetraneura colophoidea* inhabits a cockscomb gall agreeing exactly with my recollection of *Colopha ulmicola*. * * * About 1886 at Washington, Pergande first discovered the *Tetraneura* and a few years ago I discovered it here (at St. Louis, July 7, 1906). * * * *T. colophoidea* is a mss. name that got into print,† I do not know just how. Pergande says I used it years ago but I have no recollection of it. * * * A good many years ago I had some correspondence with Pergande regarding the *Tetraneura* that makes galls similar to *Colopha ulmicola* (= *compressa* Koch ? ? ?) and suppose this term *colophoidea* may have been used in correspondence then. Certainly nothing was ever published by me. * * * So I have no objection if you describe it as *colophoidea* Monell mss. I also see no objection to ignoring the *colophoidea* and giving the species any name you desire. * * * It has been my opinion that *Colopha cragrostidis* is one of the stages of *C. ulmicola* (or *C. compressa* Koch as Lichtenstein would call it) and

*See page 212.

†Ent. News, October, 1908, p. 365.

that *Tetraneura colophoidea* with similar elm galls is the same as *Tetraneura graminis* Monell. * * * That there are grass forms of these genera is one of Lichtenstein's old theories. Osborn and Sirrine give a note of all these species 'Notes on Aphididae' in Proc. Ia. Acad. Science Vol. I, part III, pp. 98-101. * * * I suppose by *Tetraneura ulmi* they mean *Tetraneura colophoidea.* * * * This *Tetraneura* has been referred to *T. ulmi* in divers publications but it is distinct. I have seen one European gall of *T. ulmi* of Europe raised from European eggs. See Can. Ent. January 1882, page 16. Monell 'Notes on Aphididae'* I do not remember now whether I ever got any winged specimens. I do not think there is any other authentic record of *ulmi* in U. S. * * * I have examined hundreds of specimens of *Colopha ulmicola* and find venation very constant. I have also examined hundreds of the *T. colophoidea* and find its venation always constant. * * * I think they are distinct, and yet they may be dimorphs."

The name *Tetraneura colophoidea* was printed in a paper "Upon the Aphis-feeding Species of Aphelinus" by Doctor Howard in the Entomological News, October, 1908, p. 365, and in response to inquiry concerning this species by Mr. J. J. Davis, Doctor Howard wrote him, December 9, 1908,—"Mr. Pergande reports that the name *colophoidea* was a provisional manuscript name given to the insect in question some years ago by Mr. J. Monell. It has never been published so far as Mr. Pergande knows."

This insect was described and figured under the name *Tetraneura ulmi* by Mr. C. E. Sanborn* and a description by Mr. Burrows of the cockscomb gall from which it emerges is included in Mr. Sanborn's treatment of this insect. That his species is not *T. ulmi* of Europe is apparent from the description of the gall, and from the venation it is apparent that it is *colophoidea* and not *ulmicola* which he figures.

Mr. Sanborn very kindly sent me specimens of this species collected June 21, 1904, by Mr. Burrows at Lawrence, Kansas The material was labeled *Tetraneura ulmi* DeG., under which name the description of the winged form and gall are recorded in *Kansas Aphididæ.* The specimens sent me accord with *Tetraneura colophoidea* as I have found it in Maine.

Osborn and Sirrine (1893) suggest the identity of *Tetraneura "ulmi"* and *graminis.* As a slide of winged *graminis* lent me

*"I have succeeded in raising *T. ulmi* at St. Louis from eggs sent to me by Mr. Kessler of Cassel. They seem to thrive the first season but did not appear again the next year."

*Kansas Aphididae. p. 23 and Plate V, Fig. 34.

by Mr. Monell clearly established the fact that *graminis* is certainly distinct from *ulmi* of Europe but not apparently different from *colophoidea,* I wrote Mr. Sirrine, who very kindly sent me slides of both the elm species recorded in 1893 and elucidating notes. Extracts from Mr. Sirrine's letter February 28, 1910, read:

"I am sending you half a dozen slides each of *Tetraneura ulmi -graminis* and *Colopha ulmicola-eragrostidis.* Both *Tetraneura* and *Colopha* produce cockscomb galls on the elm, but those of *Tetraneura* occurred on *Ulmus americana* while those of *Colopha* were on *Ulmus racemosa.* One note states *'Colopha* and *Tetraneura* occupy the same kind of galls on elm. Are they dimorphic'? I found later that I had apparently collected leaves of both *Ulmus americana* and *racemosa* without distinguishing the difference. Furthermore I did not succeed in getting *Colopha* to colonize on *Leersia virginica* nor *Tetraneura* to colonize on *Eragrostis* sp. From the specimens sent you will see that the most constant distinction is the forking of the 3rd discoidal while the distance between the bases of the 1st and 2nd discoidals, the lengths of the antennae and body are less constant. Possibly the use of the name *Tetraneura ulmi* for a species producing a cockscomb gall while the *Tetraneura ulmi* DeGeer, described by Buckton produces a pedunculated gall, may be confusing. The following is copied from notes: *'Colopha ulmicola eragrostidis* is lighter in color than *Tetraneura ulmi graminis.* The latter has abdomen olive green with yellow tinge due to body contents, body linear throughout, thorax dusky instead of black. *Colopha* abdomen yellow with reddish tinge, head and callosities black, remainder of thorax yellow.' "

In order to secure a safe basis for characterizing the wing venation of this species 2,000 wings were examined of which 13 were abnormal in some respect. Sketches of these 13 wings are given in figures 185-197, together with a sketch of a normal wing (fig. 184). We had 1,000 specimens, 987 of which had normal venation on both sides, the remaining 13 had normal venation on one side. It will be noted that of the 2,000 wings, 1,997 had M unbranched as is typical for *Tetraneura.* This count was made from a haphazard collection of galls from *Ulmus americana* taken July 14, 1909, Orono, Maine, under the aphid number 65-09.

Bibliography.

1883. *Tetraneura graminis* Monell, Can. Ent. *14*: 16. Original description.

1887. *Tetraneura graminis.* Oestlund Aphid. Minn. p. 24.

1893. *Tetraneura graminis.* Osborn—Sirrine. Proc. Ia. Acad. Sci. *1*: pt. 3. 100 (Ins. Life *5*: p. 237.)

1901. *Tetraneura graminis,* Hunter Aphid. of N. A. Bibliography and host plants.

1886? *Tetraneura colophoidea* Monell mss.

1893. Tetraneura ulmi, Osborn-Sirrine, Proc. Ia. Acad. Sci. 1, pt. 3: 100 (Ins. Life 5: 237). Identity of *"ulmi"* (= *colophoidea*) and *graminis* suggested.

1904. Tetraneura ulmi, Sanborn. Kansas Aphididae, Part I, pp. 23-24. and Plate V, Fig. 34. Description of gall and description and figure of migrant. (Name by error as is seen from description and reference). This is the first description of *Tetraneura colophoidea.*

1908. *Tetraneura colophoidea,* Howard. Ent. News, October, 1908. p. 365. Merely listed in paper *"Upon the Aphis-Feeding species of Aphelinus."*

1909. *Tetraneura ulmicola,* Gillette. Journ. Ec. Ent. Oct. Figs. 1, 2, antenna.

TETRANEURA ULMISACCULI n. sp.

Tetraneura sp.* Patch.

(Producing an erect pedunculated gall on the dorsal side of leaf of *Ulmus montana* var. *Camperdown pendula.* Fig. 127).

Descriptive.

First generation,—apterous viviparous stem-mother. Head greenish black with bronze tint. Eyes in a group of three ocelli on each side of head. Antennæ dusky, 4-jointed, I, 0.035 mm.; II, 0.035 mm.; III, 0.1 mm.; IV, 0.055 mm. Beak extends nearly to 2nd coxæ. Prothorax, thorax and abdomen dark green with slight purple tint. Femora, tibia, tarsus dusky. Length of body 2.35 mm.; abdomen globular. Greatest width of abdomen 1.7 mm. Measurements from balsam mounts. Color description from live mature specimens examined July 6, 1909. At this date stem mothers still plump and producing in some galls, in others much shrunken.

Habitat,—single stem mother with progeny in gall. (Figs. 167, 168). Maine collection number of type specimens aphid 53-09.

Second generation,—migrants. Head black. Antenna black, 6-jointed with III, IV, V with heavy annulations, I, 0.05 mm.; II, 0.055 mm.; III, 0.24 mm.; IV, 0.065 mm.-0.08 mm.; V,

*1909. Homologies of Wing Veins of the Aphididae, Psyllidae, Aleurodidae, and Coccidae. Ann. Ent. Soc. of Am. Vol. II, No. 2. Plate XVII, Fig. 17.

0.13 mm.-0.145 mm.; VI, 0.085 mm.-0.095 mm. Annulations not completely circling the joints, these vary in number but are approximately III, 9 to 11; IV, 2 to 3; V, 6; VI, 3. Annulations on VI faint, very irregular and often run together. Beak extends a little caudad of 1st coxa. Thorax dark dorsally and ventrally. Wings with venation as usual for *Tetraneura*. Veins dark and heavy, Cu and 1st A being conspicuously heavier than the others, stigma dark. Wing expanse 6 mm. Abdomen dark green. Total length of body 2.15 mm. Measurements from balsam mounts. Color description from individuals removed from gall before flight, July 6, 1909. They grow even darker with age.

Habitat,—about 60 individuals developing in gall as progeny of single stem mother and after attaining wings migrating from gall. (Figs. 164, 165).

Maine collection numbers of type specimens Aphid 22-05, Aphid 53-09.

Pupæ. The second generation while in the pupal stage vary from dark purplish individuals to light individuals having dusky head and prothorax; white pellucid thorax, wing pads, antennæ, and legs; and pale tan abdomen. Body somewhat flocculent. Antenna 6-jointed. (Fig. 166). Aphid No., 53-09.

Galls. The galls are pedunculated sacs with height of from less than ½ to 1 inch. They are bright yellowish green with a varnished look and much paler than the elm leaf. The older galls have some pinkish tints. The opening into the gall which is on the ventral side of leaf is surrounded with pale fuzzy hair which extends a short distance up into the gall. Inside wall of gall with slight longitudinal ridges. The galls occurred in numbers from 1 to 36 on single leaf. Where most numerous some of the galls were small and not typical in shape. They occur on the dorsal surface of leaf between the lateral veins. No galls were found exactly on the mid rib, though they were often very near. The mature gall as a rule had an irregular circular hole in the side through which the migrants made exit.

Biological.

On June 26, 1909, the galls about Orono were pretty well grown. Most of the stem mothers at this date were not quite mature,—had not begun to produce. By July 6 some of the stem mothers were shriveled and were through producing, oth-

ers were plump and still producing though the older of the progeny were pupæ about ready to molt. At this date the migrants in some galls were already winged. At this time most of the galls pop open on one side, a circular hole for exit being thus provided. The opening into the gall from the ventral side of the leaf was apparently used for exit in the galls of less vigorous growth which did not split on the side. So far as the examination of many galls revealed all the progeny of the stem mother acquired wings, no apterous form except the stem mother being found in any gall examined.

The migration took place the last of June and first of July, but the fate of the migrants and their progeny was not ascertained. It is probable that they, like the European elm *Tetraneura* and *Tetraneura graminis,* accept some grass species for the summer host and that migrants from grass return to the elm in the fall to deposit the true sexes which consign the winter egg to the crevices of the bark.

Discussion.

Galls of this species I have collected at Orono, June 30, 1904; July 3, 1905; June 26 July 6, 1909, and specimens of galls with winged individuals were sent me from North Berwick, Maine, July 12, 1906. The species of the elm was not recorded except for the 1909 collection which was made from an ornamental elm, *Ulmus montana* var. *Camperdown pendula.*

I do not know that *ulmisacculi* will prove to be distinct from European species. But the European literature on the *Tetraneura* of the elm,—*ulmi, alba* and *rubra,* is not definite even for Europe, and it is certainly not desirable to add to the confusion already existing by trying to merge *ulmisacculi* with any of them unless the identity can be definitely proven. A brief discussion of the difference between *ulmisacculi* and the European species is of interest in this connection.

"Deep red hairy galls"* would be sufficient to exclude *ulmisacculi* from *rubra.* Lichtenstein (1880) gives in his table "Insect white, stem mother with 4-jointed antenna," for *T. alba,* which would exclude *ulmisacculi,* as this is a decidedly dark and not a pale species. In the same table Lichtenstein gives "Insect black, the stem mother with 3-jointed antenna,"

*Buckton, Vol. III, 131.

for *T. ulmi,* which would exclude *ulmisacculi,* the stem mother of which has a 4-jointed antenna. Buckton's description of both insect and gall of *ulmi* accord fairly well with *ulmisacculi,* however, and it is possible that *T. ulmi* Buckton is not *T. ulmi* of the continent but the same as *ulmisacculi.*

TETRANEURA ULMI

There are the following records of *Tetraneura ulmi* in America. As is elsewhere shown in this present paper, there is no evidence that any one has taken authentic specimens of *ulmi* of Europe in America except Mr. Monell, who introduced demined material from Europe but did not succeed in rearing this species except the first year.*

1883. *Tetraneura ulmi,* Monell, Can. Ent. *14*: 16. Brief record of introduction.

1887. *Tetraneura ulmi,* Oestlund. Aph. Minn. p. *24.* "Recorded as American though not yet found in Minnesota."

1890. *Tetraneura ulmi,* Packard. Forest Insects, p. 283. Listed for elm.

1893. *Tetraneura ulmi,* Osborn-Sirrine *not* Linn. Proc. Ia. Acad. Sci. *1*: pt. 3, 100 (Insect Life 5: 237). Name used for the cockscomb *Tetraneura* (*T. colophoidea graminis*) not *ulmi* of Europe.

1901. *Tetraneura ulmi,* Hunter, Aphid. of N. A., p. 76. Bibliography.

1904. *Tetraneura ulmi,* Sanborn *not* Linn. Kansas Aphid. pp. 23-24, Plate V, fig. 34. Description of the cockscomb *Tetraneura,* (*T. colophoidea graminis*) not *ulmi* of Europe.

Some of the more important European references to ulmi are as follows:—

Tetraneura ulmi, Uebers, *3*: 58 pl. 4, f. 15-17.

Tetraneura ulmi, Burm. Handb. *1*: 91.

1843. *Tetraneura ulmi,* Kalt. Mongr. 189.

1844. *Tetraneura ulmi,* Ratzeburg. Forst-Insecten. Dritte Ordnung. pp. 222 and Taf. XIII, F. 2.

1857. *Tetraneura ulmi,* Koch, Pflanzenläuse 288, f. 358, 359.

1878. *Tetraneura ulmi,* Kessler *Die Lebensgeschichte der auf Ulmus campestris vorkommenden Aphiden-Arten.*

1879. *Tetraneura ulmi,* Courchet. *Etude sur les Galles produits par les Galles produits par les Aphidiens.*

1880. *Tetraneura ulmi,* Kessler. *Neue Beobdachtungen an den auf Ulmus campestris vorkommenden Aphiden Arten.*

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*"The eggs of *T. ulmi* from Kessler were on a piece of bark which I tied to a small cultivated European Camperdown weeping elm, at St. Louis, Mo.," according to a recent letter from Mr. Monell.

1880. *Tetraneura ulmi,* Lichtenstein, *Les Pucerons des Ormeaux. La Feuille des Jeunes Naturalistes.* Aout Sept. pp. 1-7.
1881. *Tetraneura ulmi, Buckton.* British Aphides. Vol. III, pp. 131-135, Plate CXIV, figs. 5-13.
1895. *Tetraneura ulmi,* Judeich und Nitsche. *Forst-insektenkunde* Band II, p. 1208 and Fig. 329 c.
1896-1897. *Tetraneura ulmi* DeGeer, Cholodkovsky. *Zool. Anz.,* 1896 No. 520, pp. 508-513; (rev. in *Zool. Centbl.,* 4 (1897), No. 26, pp. 918-919. By O. Nüsslin (Karlsruhe).
(1899) *Tetraneura ulmi,* Cholodkovsky. *Zool. Anz., 22* No. 602, pp. 468-477. Descriptive and biological notes on several species of plant-lice.
1902. *Tetraneura ulmi,* Kerner. *Nat. Hist. of Plants.* Vol. II, p. 533. Figure of galls.
1902. *Tetraneura ulmi,* Connold. *British Vegetable Galls.* pp. 247-248. Plate 108. Description and photograph of galls.

PEMPHIGUS ULMIFUSUS

(The Red-Elm Gall-louse produces an erect spindle-shaped gall about 1 inch in height on the upper side of the leaf of the red or slippery elm,—*Ulmus pubescens* Walt., *fulva* Michx. Fig. 150).

This insect which was named in 1869 with only a few words of descriptive comment, remained with no real description until 1904, when it received that attention under the name of *Schizoneura* sp. by reason of a specimen with a branched M as is not infrequent for this species. The appended bibliography gives a brief outline of the character of the discussions, for the most part meagre, which have been given this species during the 40 years since it was recorded by Walsh. So far as has been authentically determined the gall is known to occur only on the red or slippery elm,—*Ulmus pubescens* Walt., *fulva* Michx., and the accounts which record it from *Ulmus americana* are probably in error.

My own acquaintance with this species is limited to Minnesota material given me by Professor Oestlund and Illinois material loaned me by Mr. Davis from the Thomas collection and his own recent collections. From these, I was able to make the following measurements and present figures 146-150.

Total body length 2.15 mm. to tips of closed wings, which is approximately the same as Walsh's 0.07 inch for the same measurement. Wing expanse 3.8 mm.-4.5 mm. Antenna 6-jointed; III, 0.22 mm.-0.26 mm.; IV, 0.09 mm.-0.1 mm.; V,

0.12 mm.-0.14 mm.; VI, 0.13 mm.-0.16 mm.; III exceeding IV+V and less than V+VI. Annulations III, 18-22; IV, 4-7; V, 7-10; VI, 9-11. The antenna of the pupa previous to the molt shows, through the smooth pupal segments, the annulations of the mature insect like a coiled wire (fig. 149).

The wings (fig. 146) are normally as usual for *Pemphigus,* but M in this species is not very stable, a branch of this vein being not uncommon which gives us the wing of a *Schizoneura.* Fig. 147 gives a weak example of this where M is branched merely at the tip. This tendency was commented upon by Walsh in his first record of the insect. Professor Oestlund states that it is a very common tendency in Minnesota, and the slide from him which is labeled "125/'98 (383) B-64. 7/12" has 3 winged specimens, one of which has M branched in both wings and the other two have M simple on one side and branched on the other. Of 18 specimens collected by Mr. Davis, 7 July, '07, Leroy, Illinois, 4 specimens had M branched on one side and one other had one M and one Cu branched.

The gall which was used for Fig. 150 is over 1¼ in. (35 mm.) long. Besides this I have seen only 4 or 5 galls of this species from Minneosta and Illinois, none of which were so large. Mr. J. J. Davis measured one gall of *P. ulmifusus* collected at Villa Ridge, in Southern Illinois, June 4, 1892, and found it to be 22 mm. long, 6½ mm. wide at widest point and 2¼ mm. wide at the neck.

Mr. Sanborn quotes the following description of the gall, which is the best available, for which reason I am glad to make use of it in this connection:

"This gall occurs on the dorsal side of the leaf of the elm (*Ulmus americana*?). The gall is large and elongated, tapering at both ends; sides sunken and irregular, due to the thin wall of the central cavity; 2½ c. in height and 1 c. m. at its greatest diameter. The walls are of a leathery texture, green when young, turning to a straw color upon reaching maturity. The gall is firmly fastened to the leaf. The internal side of the gall is covered with plant-lice which emerge through a crack which occurs along the side of the gall, or some few through the small opening on the ventral side of the leaf."

The original "description" occurs in an incidental manner in a foot note and as it is no longer easily accessible it is quoted entire as follows:

"The Red Elm, or Slippery Elm, as we have ascertained by close and long-continued observation, never bears these cockscomb-like galls. But

there is occasionally found upon the upper face of its leaves in small numbers, a solitary gall with quite a thin rind, about an inch long, shaped much like one of those depicted in figure 86,* and hitherto undescribed. It is made by a species of plant louse belonging to the same genus (*Pemphigus*) as Fig. 88.† In Europe a well known elm-gall (*ulmi*) is made by another genus of Plant-lice (*Byrsocrypta,* Haliday = *Tetraneura,* Hartig). So that on the same genus of trees, the Elm, we have three distinct galls made by three distinct genera of plant-lice; the more general rule being that the same genus of gall-makers attacks the same genus of plants. The above described gall on the Red Elm which we may call the Spindle-shaped Elm-gall (*Ulmi fusus*), was first brought to our notice by Dr. W. M. Smith of New York; but we have since found several specimens in South Illinois. The winged insect (*Pemphigus ulmi-fusus,* n. sp.) which only measures 0.07 inch to the tips of the wings, and is of a uniform dusky color, occurred July 11th. Out of 28 specimens, two have both wings, and one a single wing veined precisely like those of *Eriosoma* (Fig. 70, c. p. 82)—thus affording a practical exemplification of how one genus of plant-lice may gradually in the course of indefinite ages merge into another."

Bibliography.

1869. *Pemphigus ulmifusus* Walsh:—Am. Ent. Vol. 1, page 109, foot note. Original description.

1879. *Pemphigus ulmifusus,* Thomas:—Rept. Ent. Ill. VIII, (Thomas III) page 153. Brief remarks.

1887. *Pemphigus ulmifusus,* Oestlund:—Aph. of Minn., page 24. Listed for United States.

1890. *Pemphigus ulmifusus,* Packard:—Forest Insects, page 283. List of insects injurious to elm.

1901. *Pemphigus ulmifusus,* Hunter:—Aph. of N. A., page 79. Bibliography.

1902. *Pemphigus ulmifusus,* Cook:—Galls and Insects Producing Them. Ohio Nat. Vol. II, No. 7, p. 265 and Fig. 14, a. b. Discussion of structure of gall.

1903. *Pemphigus ulmifusus,* Cook:—Galls and Insects Producing Them. Ohio Nat. Vol. III, No. 7, p. 425 and Fig. 49, a. b. Discussion of structure of gall.

1904. *Schizoneura* n. sp.:—Sanborn. Kansas Aphididae. pp. 28, 29 and Plate VI, fig. 41, 41a. First real description of this species. Also a description of the gall by Mr. Burrows. This species described and figured as *Schizoneura* from a specimen having M forked as is not unfrequent with this species.

1905. *Pemphigus ulmifusus,* Cook:—The Insect Galls of Indiana. (From 29th Ann. Rept. of the Dept. of Geol. and Nat. Resources of Indiana. 1904, pp. 801-867) p. 849. Bibliography in part.

*A reference to the grape-vine filbert gall, *Vitis coryloides.*

†*i. e. Pemphigus vagabundus.*

1905. *Pemphigus ulmifusus.* Washburn 10th Ann. Rept. of the State Ent. (Washburn 4th) p. V. Fig. 2. Photograph of galls on leaf.

1908. *Pemphigus ulmifusus,* Jackson. A Synopsis of the Genus Pemphigus. Proceedings of the Col. Hort. Soc., p. 204. Bibliography. Brief description.

1909. *Pemphigus ulmifusus,* Gillette Jour. Ec. Ent. Oct. Fig. 10, antenna.

SCHIZONEURA AMERICANA

Since the excellent account of Riley's so little work has been done with this species that probably a total quotation of the original publication will be more valuable in this paper than anything else which is at present available. It is, therefore, given entire:

"SCHIZONEURA AMERICANA n. sp.

"(Curling and gnarling the leaves of the White Elm (*Ulmus americana*), forming thereby a sort of pseudo-gall. The curl made by a single stem-mother in the spring takes the pretty constant form of a rather wrinkled roll of one side of the young leaf, but, according as there is more than one stem-mother, or as several contiguous leaves are affected, the deformation assumes various distorted shapes, sometimes involving quite large masses of the leaves).

BIOLOGICAL.

"There is a good deal of irregularity in the time of appearance of the different generations, but the general history of this species, as I have observed it for several years, is herewith given. There is much greater difficulty in fully tracing the life-history of one of these small creatures than might be supposed. They languish in confinement and ill bear handling. To trace their growth and movements in a state of nature requires vigilance and perseverance, and a great deal of time; and I have been fortunate, in my studies of this and the next species, in securing the patient aid of Miss M. E. Murtfeldt of Kirkwood, Mo., a lady to whom I have already had repeated occasion to express my indebtedness.

"If, during the winter, we carefully examine the cracks and crevices of an American or White Elm that was badly infested with this leaf-curling species the previous summer, we shall be pretty sure to find its impregnated egg—a minute, dull-yellowish, ovoid object, about 0.5 mm. long (Fig. 128, *a*), either free or still more or less effectually covered with the parent's dry skin, which faintly shows the insections that characterized the living female. The same spring influences that cause the leaf-buds to swell and open, likewise induce the hatching of this winter egg, and the little creature that issues from it instinctively crawls to the more terminal twigs and branches, and settles upon the first tender leaflet it meets with. It constitutes the stem-mother, or *first genera-*

tion, and, stationing itself on the under surface of the leaf, very soon causes the same to swell and curl by the irritation and punctures of its beak. The curl is usually from the lateral edge, and the more normal form it takes is shown at Fig. 128, *c*. It is, however, very irregular, and takes on many different forms, according as it is produced by one or several stem-mothers settling on the same leaf, and as it affects a portion of one leaf only or embraces several from the same bud. At first, pale yellowish-red with dark members, the stem-mother increases in size more or less rapidly, depending to some extent on the development of the leaf. Moving about in her curled house, within which she is destined to live and die, this stem-mother goes through her last moult, and attains maturity about the twelfth day from the time of hatching. This period may be lengthened by unfavorable weather, as an indefinite period of legarthy, both of plant and insect, may ensue, after hatching, if the temperature be too low. The number of molts I have not definitely ascertained, but from analogy there will be three. Having attained maturity, she commences peopling her pseudo-gall with young at the rate of about one every six or seven hours, according to the temperature, increasing in bulk and prolificacy from day to day, until by the early part of May, in the latitude of Saint Louis, she has attained her fullest development, and soon perishes. She may attain to nearly four millimeters in length, and, with greatly swollen body, be almost as wide (Fig. 128, *b*). Her immediate issue, or the *second generation,* are like her in many respects, but never grow to be quite so large. The individuals of this generation soon accumulate in great numbers around her, and in their turn commence to bring forth young, some remaining within the original curl, others scattering to found new colonies. Their issue, or the *third generation,* show certain marked structural differences from the first (see description), and are destined to become winged.

"During most of the month of May, we may find, where large clusters of leaves are affected, the few more or less exhausted stem-mothers, and these second and third generations in every stage of development. As the lice increase in number, the leaves no longer protect them but present on both sides multitudes of busy atoms—livid, old, and paler young—those with wings and those getting wings—interspersed with white exuviae, cottony secretion, and globules of pearly liquid. At the same time, in single curls of more terminal leaves, we may find the second generation of wingless mothers surrounded by smaller colonies, all of which will become winged. The winged females (Fig. 128, *d*) are short-lived, bringing forth a dozen or more pseudova at average intervals of about half an hour. The glossy pellicle that compresses all the members of their newly-born issue is ruptured very shortly after birth, and is worked off in the course of about ten minutes. These facts are easily ascertained by confining the winged mother, but the exact positions to which the pseudova are naturally carried I have not been able to definitely learn; but we may rest pretty confident that they are consigned both to the leaves and to the twigs. The young lice, forming the *fourth generation,* are very active, running swiftly in all directions. In color, they are at first of a pale and bright red, but soon acquire a

brownish tint. In general appearance, they resemble the young from the stem-mother. The beak is very long, thickened at the end, which always projects beyond the tip of the abdomen, and terminates in a sickle-like point. Experiments made by attaching and confining these young to the trunk of the tree show that they do not flourish thereon, but naturally crawl out to the more tender, terminal leaves, which they immediately begin to curl. They may be found scattered over an infested tree, with their beaks for the most part inserted in the tender leaf-stem or in the midrib on the under side, the leaf in such case already beginning to show the effect of the poisonous puncture. They are, however, able to sustain themselves on the tender bark of twigs alone, and may be found nearly fully-grown, there exposed to view and enveloped in the white cottony matter, which brushes off at the slightest touch. When full-grown, they commence reproducing, and their progeny, under favorable circumstances, becomes exceedingly abundant. The growing points of the tree are affected with larger or smaller colonies, crowding and covering both the surfaces of the leaves, the petioles, and the stem. I have known young Elm trees to be so thoroughly covered with these lice, in the earlier part of June, that not a single leaf was unaffected, and upon giving the tree the slightest jar there would be a perfect shower of the liquid globules excreted by the lice. At this season of the year, when the lice are thus numerous, they may be found during the heat of the day actively crawling over all portions of the tree—a veritable migration, necessitated by the want of sufficient succulent leaves, but evidently premature and destined to be the death of the individuals participating in it, excessive multiplication here, as in all other cases, obliging the destruction of the excess. While the individuals thus wandering are mostly the younger ones, the migrating instinct seems sometimes to possess individuals of all ages, especially where the tree is badly affected; and that they perish is proved by the mass of dead lice which in such a case may be found around the base of a tree. So far as I have been able to learn by confining specimens of the *fifth generation,* which is very similar to the fourth, but with shorter promuscis, the fifth reproduces like the fourth without acquiring wings. The individuals of the *sixth generation,* on the contrary, all acquire wings, the pupa being active, with but a small amount of flocculence, confined to the posterior part of the body. The winged lice of this sixth generation abound during the latter part of June and the early part of July. They resemble those of the third generation, except that they are perhaps on the average somewhat smaller and paler, and less prolific. They instinctively congregate on the bark, and consign to the crevices, and sheltered parts thereof, their young, which, as in the fourth generation, are enveloped in a sort of pellicle. These young also resemble the young of the fourth generation in general form, but have very short and stout beaks. Instead of being active, they are quite sluggish, congregating in clusters in the sheltered portions of the bark, and being essentially bark-feeders. The color soon inclines strongly to salmon or orange, and, after two or three days of sluggish existence, they shed their skin, and become more ac-

tive, penetrating more deeply into the interstices of the bark, and huddling together in groups of various sizes. They are now of a pale buff, or, more correctly, salmon color, the surface at first smooth and polished, but becoming in some instances slightly pulverulent. Simulating closely the color of the bark, and being quite small, they are not easily detected, unless in great numbers. A careful examination shows that they have entirely lost the beak, and that they consist of both males and females, the females being the larger, and the males showing the genital characters given in the description. They live grouped together for several days with little motion, the female (Fig. 128, *e*) increasing in size by the enlargement of the single egg contained in her body. Both soon perish, leaving among their shrivelled bodies the shining, reddish-brown winter egg, either partially or entirely covered by the parent's skin.

"On the 16th of June, 1877, I met with an isolated tree at Malvern, Iowa, belonging to Mr. H. K. Follett, which had been very badly infested with this species. The winged individuals crowded the trunk, and had perished in such quantities around the base of the tree as to lie in a matted mass three or four inches thick, being greedily devoured by their numerous enemies. One could not break off the smallest piece of the bark without finding the exposed interstices crowded with the salmon-colored sexual individuals.

"Among the more prominent of the natural enemies of this species, I have noticed, of Coleoptera, *Coccinella 9-notata, Coccinella sanguinea (munda)* Say, *Hippodamia convergens,* and several species of *Scymnus.* I also found feeding upon them the perfect beetle of *Podabrus modestus,* and the Hemipterous *Cyllocoris scutellatus,* Uhler, and *Capsus linearis,* Beauv. A Lepidopterous inquiline, namely, the larva of *Semasia prunivora,* Walsh is also quite common within the curled leaves, feeding both on the lice and on the substance of the leaf. A large green *Syrphus* larva and several *Chrysopa* larvae also prey upon them.

Descriptive.

"*Schizoneura americana* (Fig. 128).—*Impregnated egg* 0.5 mm. long, gamboge-yellow, inclining to brown in color, with no especial external sculpture.

"*First generation.*—Stem mother: Pale yellowish-red, with black members when first hatched; the red deepening and becoming purplish or livid with age. When mature, averaging 3.5. mm in length, globose or pyriform, with subobsolete honey-tubes and six dorsal rows of darker piliferous and tuberculous spots. Antennae 5-jointed, joint 3 more than equalling 4 and 5 together in length.

"*Second generation.*—Differing in no essential respect from the preceding, except that the individuals do not attain so great a size. Bright brownish-red when born, they soon become livid brown.

"*Third generation.*—Mature, winged female: Alar expanse 5 to 5.6 mm. Body dusky ,the abdomen slightly reddish; legs either dusky or yellowish-red. Antennae as long as head and thorax together, dusky, rarely yellowish, not pilose, but with a few short setous points; 6-jointed

the 1st and 2nd joints slightly bulbous; 3rd either surpassing or equaling in length the 4th, 5th and 6th together, which are subequal; the terminal joint usually the shortest, the apical sub-joint being normal, and in some cases sufficiently constricted to resemble an additional joint; joints 3, 4, and 5 rather distinctly annulated the constrictions being generally quite deep, and producing a moniliform aspect, there being on an average 22 such on joint 3. Tarsi with the basal joint distinctly separated into a lobe, the claws strong, and in length twice the diameter of the tarsus. Wings hyaline: front pair with the veins becoming obsolete at tips; stigma subhyaline, either of a yellowish tinge or somewhat dusky; stigmal vein starting from the middle of the stigma and normally curved; cubital vein obsolete for nearly one-third its length, the furcal forming with it almost a point; the terminal distance between first and second discoidals equal to about five times that between their bases (often rather more); terminal distance between furcal and cubital and second discoidal veins subequal that between stigmal and furcal slightly shorter, that between second and first discoidal one-third greater, and about equal that between stigmal and tip of stigma. Hind wings with the subcostal vein almost straight, there being no curve where it gives off the discoidal veins, which are obsolete at their extreme base and not confluent with it. (The wing venation is very constant. Out of nearly 100 specimens examined, I have found only an unusual shortening of the cubital in two individuals). The larva and pupa in this third generation differ from the winged insect in being more reddish and in having the antennae ringed with less distinct constrictions, in the legs being paler, in the claws being stronger, and in the basal joints of tarsus being more connate with the terminal joint. They have a distinct annulated elevation at each side posteriorly—a sort of pseudo-honeytube. When first born they are of a pale dull yellow, and the antennal joints are more nearly subequal in length.

"*Fourth generation.*—That from the first winged females: Differs from the preceding in the promuscis being much longer, in the antennae having but five joints, the third being somewhat longest and the first the shortest, but all often being of much more nearly equal length, with no annulated constrictions. The color is more decidedly orange. When newly hatched, the thickened end of the promuscis often extends one-half the length of the body beyond anus. The legs are also long and stout, and the basal joint of the tarsus is distinct, but not separated. The capitate hairs are obsolete. It is born with an enveloping pellicle or pseudovum, and though of a bright red with pale legs at first soon becomes brownish, with dark members.

"*Fifth generation.*—The counterpart of the second.

"*Sixth generation.*—Second winged: Resembles the third, but usually rather lighter colored, with the wing-veins, the spinous armature of surfaces, and the constrictions of antennae less strong, and with the third joint of antennae rather less in length than the terminal three together.

"*Seventh generation.*—True sexual individuals: Born within an egg-like pellicle. With stout promuscis reaching to between middle and hind

coxæ; the antennae 5-jointed, with the joints subequal. Bark-feeding. Orange in color. Undergoing one moult and then being at once distinguished from the other forms by the brighter orange-yellow color, the rudimentary mouth, the more simple eyes (composed of three facets), by the shorter, 5-jointed antennae, the joints subequal in length; by the shorter legs, with smaller claws to the tarsi, and more distinct terminal capitate hairs or pulvilli. The skin is transparent, the body filled more or less with fatty globules. The female is nearly pyriform, and averages 0.4 mm. in length. A single egg is visible through the translucent skin, and, according to age, occupies more or less of the whole of the body. The male is narrower and smaller, the penis being bulbous, with a couple of spine-like genital clasps.

"This species is very closely allied to the European *S. ulmi* (Linn.), and until I was able to compare it with actual specimens I was in doubt whether to look upon it as a mere variety or a distinct species. Judging from Kessler's figure and description of the European leaf-curl, and by a figure sent me by Mr. Buckton, it differs from ours, 1st, in bending upward, *i. e.,* the stem-mother settles on the upper instead of the under side of the leaf; 2nd, in having a number of small rounded or verrucose swellings. These differences in their dwellings are strongly presumptive of structural differences in the insects themselves; and the fact that *S. americana* does not attack the European Elms, either in Shaw's Botanical Gardens at Saint Louis, or in the grounds of the Department of Agriculture, points in the same direction. Differences are indeed easily enough made out if we take the more or less imperfect descriptions and figures of *ulmi,** but are less apparent when the actual specimens are compared. The following are the more important differences, least subject to variation, between the winged female of *ulmi* as compared with those of *americana*: *ulmi* is a longer-winged species averaging 7.3 mm. in expanse; the abdomen, wing-veins, and stigma are darker; the terminal distance between 1st and 2nd discoidals slightly greater; the 3d joint of antennae is relatively longer; the annulations are less deep and more numerous (those on 3d joint averaging 30); joints 5 and 6 are smoother, *i. e.,* without annulations, but they are more setous; joint 5 is shorter than 4; the apical, narrowed part of 6th joint is relatively longer and more pointed; the subcostal vein of hind wings is less straight; the cubital vein is often continuous to very near the subcostal, while I have not found any tendency of the kind in *americana,* the tendency being in the opposite direction, or to become shorter ;the 2d discoidal of hind wings shows a tendency to fork; the hooklets on costa of hind wings are 3 in number while in *americana* there are normally four;† the legs are more setous."

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*"Koch's figure (evidently copied by Kessler) is faulty in several respects, and fails to indicate the hook-angle of hind wings, or the corresponding thickening of front wings a fault that is, however, common to most of Koch's figures.

†"These hooklets get so easily broken off that they are not to be relied on; yet the normal number of most of the *Pemphiginae* I have examined

There seems to be but one significant point not entirely settled in Riley's life-cycle account, and that is the natural location of the *fourth generation* (*i. e.*, the progeny of the spring migrants). Without definitely proving it he states that "we may rest pretty confident" that the pseudova of the winged mother are consigned both to the leaves and to the twigs, for he says that this *fourth generation* may be found on the tender leaf-stem or in the midrib on the under side. But of especial interest is his statement, "They are, however, able to sustain themselves on the tender bark of the twigs alone, and may be found nearly full grown, there exposed to view and enveloped in the white cottony matter, which brushes off at the slightest touch."

Although I have no definite proof, it is my belief that *Schizoneura rileyi* as common with us in the tender bark of young elms is the summer form of *americana*. I can find no stable character to separate *rileyi* from *americana* and have for several years believed them to be the same species. Professor Gillette (1909) states that he "inclines to believe the two forms are one species" because he is unable to separate them with any certainty.*

Riley figures the antenna of the second generation with 5 segments and states that the 5th is the counterpart of the 2nd generation. A collection of 5 apterous viviparous forms taken from the elm leaf curl, July 16, 1909, all had antenna 6-jointed. Fig. 154.

Prof. J. M. Aldrich (1901) gives a very important record of the spring and return migration of *americana:*

"Some of the specimens in the leaves develop wings and fly to new locations during the early part of the summer; and about midsummer all the rest do the same, so the old leaf-nests are deserted. Where they go has not yet been found out. There is a closely related form in Europe that migrates to grass and it is probable that ours do the same.

"In September the return migration takes place. Last year it was a very conspicuous affair in Moscow, as all the trees, of whatever kind were surrounded by a hovering swarm of delicate, winged lice. These return migrants do not eat anything, and after a few days their dead bodies were very abundant on the trunks of many trees, filling the

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is 3, while in *Hormaphis* there are but 2. The fact that in *Sc. americana* there are 4 is therefore interesting, and of some value in this connection."

*Notice, also, the comment on *Schizoneura fodiens* Buckton, p. 233 of this bulletin.

crevices of the bark. All that they do on their return is to bring forth a new brood of little lice. These young develop into the true egg-laying form, male and female. They are wingless and mouthless very small when grown, bright orange in color, and seem to have no object in life except the deposition of eggs, since they can not eat or fly. The eggs are placed in the deepest crevices of the bark, especially those that are tangential to the tree, and are not easy to find. The small lice perish after depositing eggs leaving only the latter to survive the winter.

"Last fall the egg-laying brood were abundantly produced on all kinds of trees promiscuously. Their eggs must have been deposited on the same trees, but there is no evidence to show that the young can subsist on any trees but the elm, so it is safe to assume that all on other trees perished.

"The migration of this louse seems not to have been noticed by other entomologists. It was strikingly apparent last year with us."

Sanborn (1904) describes carefully and figures the winged form of *americana* and adds:

"This form was taken June 16, on the elm (*Ulmus americana*). They colonize the ventral side of the leaves, causing them to curl. When numerous they give the leaves a whitish appearance and cause the terminal ones to bunch together, which gives the lice more protection. When the leaves begin to turn yellow and look sickly from the attack of the aphids, the latter are acquiring wings and beginning to migrate. This migration, according to my friend Mr. E. H. Tucker's observation, takes place most conspicuously about twilight, for he says: 'In the twilight of the evening I took several winged specimens. The air had floating in it numerous white insects. After capturing some I noticed that it was a cottony secretion which gave them their white appearance and also sustained them or caused them to be wafted along by the wind'. According to this statement, the flocculent material acts as a sail by which these insects are carried as well as by the aid of their wings."

I have observed the migration from the leaf curl in mid-July at Orono.

In the present paper, the object of which is not taxonomic, this species is treated under the name given it by Riley, although I am of the opinion of Thomas, who commented in regard to this, "it is doubtful whether it should be considered as distinct"* from *ulmi*. Professor Gillette (1909) gives *americana* as synonym of *ulmi* of Europe. Perhaps a brief discussion of Riley's reasons for considering this distinct† may not be without interest. He states that:

1. '*Ulmi* is a longer winged species averaging 7.3 mm. in expanse.' (Absolute size can hardly be held a specific distinc-

†Riley and Monell on Aphididae. p. 9.

*Thomas III Report, page 204. 1879.

tion. Many specimens of *americana* taken July 1, 1909, in Maine attain 7 mm. wing expanse).‡

2. 'With *ulmi* the abdomen, wing veins, and stigma are darker.' (This difference might perhaps be accounted for by the difference between newly molted and aged individuals).

3. 'With *ulmi* the terminal distance between 1st and 2d discoidals is slightly greater.'

4. 'With *ulmi* the 3rd joint of antennæ is relatively longer; the annulations are less deep and more numerous,—those on 3rd joint averaging 30.' (A Maine collection of *americana* of July 1, 1909, have III with a range of from 24-30 annulations. Professor Gillette figures this species with 35 annulations).

5. 'With *ulmi* joints 5 and 6 are smooth, *i. e.*, without annulations, but they are more setous.' (Maine collection of *americana* of July 1, 1909, have V and VI smoother than Riley's figure, VI being indeed with no annulations and V having 2 to 7 and these not completely encircling the antenna).

6. 'With *ulmi* joint 5 is shorter than 4.' (This is also the case with the aforesaid Maine collection of *americana*).

7. 'With *ulmi* the apical, narrowed part of 6th joint is relatively longer and more pointed.'

8. 'With *ulmi* the subcostal vein of hind wings is less straight.'

9. 'With *ulmi* the cubital vein (M) is often continuous to very near the subcostal, while I have not found any tendency of the kind in *americana*, the tendency being in the opposite direction, or to become shorter.' (Maine 1909 material of *americana* has wings very uniformly like fig. 152, (comp. Buckton's figure of *ulmi*), and no wing with M as figured by Riley. "Cubital vein of fore wings obsolete for some distance at base, rarely traceable its whole length." O. W. Oestlund, Aphid. Minn. p. 27, 1887).

10. 'With *ulmi* the 2nd discoidal of hind wings shows a tendency to fork.' ("Freak" venation is not uncommon with aphids).

11. 'With *ulmi* the hooklets on costa of hind wings are 3 in number, while in *americana* there are normally 4.' ("Those

*For measurements of *americana* see comparison with *rileyi* footnote page —— of this bulletin.

British insects which I have examined show also four hooklets on the lower wings." Buckton. British Aphides. Vol. III, p. 100, foot note to a reference to Riley's statement in regard to *ulmi*).

12. 'With *ulmi* the legs are more setous.'

It would seem that the relative differences noted by Riley may be locational or seasonal,—at least not specific. At any rate the 1909 Maine *americana* correspond more closely to Riley's 1879 characterization of *ulmi* (of Europe) than they do to his description and figures of *americana.*

As to the differences in the leaf-curl or pseudo-gall of *ulmi* and *americana* a mistake has been recorded. Riley* says: "Judging from Kessler's figure and description of the European leaf-curl, and by a figure sent me by Mr. Buckton, it differs from ours, first, in bending upward, *i. e.,* the stem-mother settles on the upper instead of the under side of the leaf; second, in having a number of small, rounded, or verrucose swellings."

Kessler's figure is misleading because it is inverted, that is, the ventral surface of the leaf is placed uppermost on the plate. But his description of the gall in the same publication (1878) to which Riley evidently had not access, states explicitly enough that the insects are on the under side of the leaf.†

Buckton's figure of *ulmi* leaf-curl, Vol. III, Plate CVIII, is misleading for the same reason,—it is inverted on the plate, which places the ventral side of the leaf uppermost. That Riley was mistaken nevertheless in thinking that the *ulmi* leaf-curl differed from that of *americana* in this respect is abundantly shown by the following citations.

Koch, 1857, p. 264, says of *ulmi,* "die eine seite des Blattes sich unterwärts zusammenrollt."

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*Riley and Monell on Aphididae, page 8.

†"*Schizoneura ulmi* afficirt den grössten Theil der einen Hälfte des jungen Blattes und zwar an der Unterseite der Zeit, wann dasselbe aus der Knospe hervorwächst. Dadurch entsteht auch hier intercalares Wachsthum in der Art, dass die Zellenbildung an und längs der Hauptrippe, aber in die Regel nicht bis an die Spitze und an den Grund des Blattes, am energischsten vor sich geht, wodurch der schon ausgebildete Rand sich nach der Unterseite des Blattes umbiegt und diese Blatthälfte mit der Zeit eine gelblich grüne, wulstige Rolle bildet (Fig. 5)."

Buckton, evidently with Riley's statement in mind but not clearly, states, Vol. III, p. 100:—"Prof. Riley describes an elm Aphis under the name of *Schizoneura americana,* and which he thinks is distinct from *Schizoneura ulmi* of Europe. One peculiarity of this insect is, that it rolls the leaves from below upwards, from which I gather that it feeds on the upper surfaces instead of on the lower, as with us." Buckton describes the leaf curl of *ulmi* (p. 98) as "the leaf curl from above downwards into a roll of a sickly yellow colour."

Kerner, Nat. Hist. of Plants, Vol. II, p. 533, figures *ulmi* leaf curl with the edge rolled under as with *americana.*

The beautiful photograph of several leaves curled by *ulmi* (which would portray leaf-curl of *americana* perfectly) in British Vegetable Galls by Edward T. Connold, 1902, is in accord with his description of the gall of this species, which reads in part (p. 246), "The affected half of the blade of the leaf curls downwards and under, forming an uneven but gracefully shaped roll." He states also: "Elm leaves may occasionally be found where the blade has rolled upwards and along the upper surface. They appear to be the work of the same species." This last accords with Buckton (Vol. III, p. 103): "I have occasionally plucked leaves of the elm rolled *from below upwards,* but I could not discover any unusual specific distinctions in the insects inhabiting them."

Schizoneura fodiens Buckton, the currant root louse, has been recorded as the underground form of *Schizoneura ulmi** for Europe and this point should prove suggestive for further experimental observations with *Schizoneura americana.*

*1896. N. Cholodkovsky. *Zool. Anz.* No. 520, pages 508-513.
1897. N. Cholodkovsky. *Zool. Anz.* No. 530.
1907. J. Barsacq. *Le Jardin.* Vol. XXI., No. 498, p. 348, Nov. 20.
1909. F. V. Theobald. *Insect Pests of Fruit.* pp. 221-222.
1909. Albert Tullgren. *Aphidologische Studien,* p. 169.

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1879. *Schizoneura americana,* Thomas. (III) Report of the State Entomologist Ill. VIII, p. 202. Quotes Riley's description of the seven generations. Fig. 44 after Riley. Thomas concludes (p. 204): "This as admitted by Prof. Riley is very closely allied to *Schizoneura ulmi* Linn, and it is doubtful whether it should be considered as distinct."

1879. *Schizoneura ulmi* Linn., Thomas (III) Rept. of the State Ent. Ill. VIII, p. 140.

(1885. *Schizoneura americana,* Lintner. New Eng. Homestead, 4 July,) 1885, v. 19, p. 269.

1890. *Schizoneura americana,* Packard. Fifth Rept. U. S. Entom. Com. p. 279. Extract from Riley Bul. U. S. Geol. and Geograph. Survey, Vol. V, No. 1.

1889. (1890.) *Schizoneura americana,* Perkins. Third Ann. Report Vt. Agric. Exp. Sta. pp. 160-162. Adapted from Riley. Bul. U. S. Geol. & Geograph. Survey, Vol. V., No. 1. Fig. 18 (after Riley).

(1890. *Schizoneura americana,* Perkins. Eleventh Rept. Vt. St. Board of Agriculture.)

1895. *Schizoneura americana,* Piper. Bul. No. 17 Wash. Agr. Exp. Sta. p. 48. Brief account.

1897. *Schizoneura americana,* Gillette Bul. Div. Ent. U. S. Dept. Agric. 9 (n. s.) : 78-79. Description of work.

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1899. (1900.) *Schizoneura americana,* Harvey. Bul. Me. Agr. Exp. Sta. No. 61. *Indem.* Ann. Rept. of Me. Agr. Exp. Sta. for 1900, p. 32. Mentioned as abundant. Photograph of leaf curl.

1900. *Schizoneura americana,* Lugger. Bul. No. 69. Minn. Agr. Exp. Sta. Id. 6th Ann. Rept. St. Ent. of the St. Exp. Sta. Univ. of Minn. pp. 168, 169. Fig. 148 after Riley.

1901. *Schizoneura americana,* Aldrich. Idaho Agric. Exp. Sta. Feby. Bul. 26, pp. 20-22. Records summer and fall (return) migration and describes true sexes. Suggests that alternate host plant may be grass.

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1902. *Schizoneura americana,* Weed. Bul. No. 90. N. H. Agr. Exp. Sta. p. 37. Brief account and photo of curled leaf.

1902. *Schizoncura americana,* Cook. Galls and Insects Producing Them. Ohio Naturalist. Vol. II, No. 7, p. 265 and Fig. 12. Discussion of structure of gall.

1903. (1904.) *Schizoneura americana,* Washburn. Bul. No. 77. Minn. Agr. Exp. Sta. Injurious Insects in 1902. Idem. 11th Ann. Rept. State Ent. of Minn.) p. 45. Mere mention.

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1905. *Schizoneura americana,* Cook. The Insect Galls of Indiana, p. 851—brief mention with reference. (From 29th Ann. Rept. of the Dept. of Geol. and Nat. Resources of Indiana 1904, pp. 801-867).

1905. *Schizoneura americana,* Felt. N. Y. St. Mus. Memoir *8*: pp. 172, 177-178. Description of leaf curl, and life history adapted from Riley.

1909. *Schizoneura ulmi* (*americana*), Gillette. Journ. Ec. Ent. Oct. Fig. 16. Antenna.

SCHIZONEURA RILEYI

Eriosoma ulmi Riley.

(Found clustered in woolly bunches on trunk and branches of young elms—*Ulmus americana,* causing knotty growth. Fig. 163).

Descriptive.

———*? generation, apterous viviparous form.* Head, antenna, and thorax light brown. Legs light brown with dusky points. Abdomen brown and very flocculent. Antennæ 6-jointed, III, 0.22 mm.; IV, 0.08 mm.; V, 0.09 mm.; VI, 0.1 mm. Total body length 2 mm Color description from live mature specimens examined August 4, 1906. Measurements from balsam mounts.

Habitat,—Closely packed in woolly bunches on trunk and branches of young elm, causing knotty growth of wood. Maine collection numbers,—Aphid 69-05, Aphid 95-06, Aphid 89-08.

———*? generation, winged viviparous form.* Head and eyes black. Antenna* black, 6-jointed, III, 0.4 mm.-0.5 mm.; IV, 0.11 mm.-0.135 mm.; V, 0.13 mm.; VI, 0.09 mm.-0.11 mm. Number of annulations, III, 17-22; IV, 4-6; V, 7-9; VI, 3-4. Prothorax and thorax black. Wing expanse, 6.25 mm.-6.50 mm. Veins slender and light brown. Shape of wings and trend and extent of veins as in *americana* (Fig. 157). Femora dusky at distal part, tibia very pale, tarsus dark. Abdomen dark brown and flocculent. Color description from live speci-

*For comparison the antenna of *Schizoneura americana* of Maine collection 5-09—July 1, 1909, is given: III, 0.4 mm.-0.5 mm.; IV, 0.18 mm.-0.19 mm.; V, 0.15 mm.-0.165 mm.; VI, 0.13 mm.-0.14 mm. Annulations III, 24-30; IV, 8-11; V, 4-7; VI, with irregular ridge at base of spur. Wing expanse 6.5 mm.-7.0 mm.

mens examined August 4, 1906. Measurements from balsam mounts.

Habitat,—Pupæ developing in woolly bunches on trunk and branches of young elm together with apterous viviparous form just described.

Maine collection number, Aphid 95-06.

———*? generation, true sexes.* The minute apterous oviparous females are born with a beak which is lost with the first (and only) molt. They have a 5-jointed antenna. Total length of body 0.8 mm. This form lays but a single egg. The apterous males are but 0.55 mm. long and their bodies are slender. Their antennæ and legs are relatively much longer than those of the female. Antennæ are 5-jointed. Mature male without beak, this being lost at molt. Described from types taken Sept. 23, 1908. (Figs. 161, 162). Maine collection number, 89-08.

The original description of this insect is as follows:

"The Woolly Elm-Tree Louse—*Eriosoma ulmi,* n. sp.

(Homoptera Aphidae.)

"The White Elm is subject to the attacks of a woolly plant louse belonging to the very same genus as the preceding. This insect appears to be quite common in our State as well as in Illinois, for I have known several elm-trees on Van Buren street in the city of Chicago to be killed by it, and every tree of this description, around the court house in St. Louis was more or less affected with it last summer. The lice congregate in clusters on the limbs and the trunks, and cause a knotty unnatural growth of the wood, somewhat similar to the knots produced on the roots of the apple-tree by the other species. They are mostly found sunk in between the crevices formed by these knots, and the punctures of their little beaks cause the sap to exude in the shape of little silvery globules, which may generally be found dispersed among the knots. The down or woolly matter is secreted by them from all parts of the body, but especially from the posterior part of the back. It is of an intense white color, and is secreted in such profusion that it usually covers and hides the lice, and when they are numerous, gives the limbs from a distance the appearance of being covered with snow. They make their appearance during the latter part of May, and by the latter part of June the winged individuals may be found mixed up with the larvae and pupae. I have experimentally found that a washing with a weak solution of cresylic acid soap will kill them instantly, and they are thus easily exterminated. They are also preyed upon unmercifully by the larvae of an undescribed species of Lacewing fly (*Chrysopa eriosoma* of my MS.).

"*Eriosoma ulmi,* N. Sp.—Color dark blue. Length to tip of closed wings, exclusive of antennae, 0.12.* Wings hyaline, three times as

* *i. e.* inch.

long as wide, and more pointed at the ends than in *E. Pyri.* Costal and subcostal veins, and that bounding the stigma behind, robust and black. Discoidal veins together with the 3d forked and stigmal veins, all slender and black, the forked vein being as distinct to its base as are the others, with the fork but 1-3 as long as the vein itself and curved in an opposite direction to the stigmal vein. Antennae 6-jointed and of the same color as the body; joints 1, 2, 4, 5 and 6 of about equal length, joint 3 thrice as long as either. Legs of the same color as body.

The young lice are narrower and usually lighter colored than the mature individuals, varying from flesh or pink to various shades of blue and purple."

Biological and Discussion.

The number of generations of *rileyi* has not been ascertained The following records of my Maine collections do not throw much light on this subject, but they are perhaps better than nothing.

Aphid 69-05. Sept. 2, 1905. Present in great numbers in woolly clusters along trunk of small elms at Orono. Apterous viviparous form and nymphs. This material was determined by Mr. Pergande as *Schizoneura rileyi* during the winter of 1905-06.

Aphid 95-06. August 4, 1906. Orono. Apterous and alate forms present on trunk of young elm.

Aphid 7-08. June 16, 1908. Woolly mass on trunk of small elms. Winged viviparous forms just developing from pupae.

Aphid 89-08. Sept. 23, 1908. Orono. Apterous viviparous forms in woolly bunches on trunk and branches of young *Ulmus americana,* causing knotty growth. The progeny of these apterous forms were the true sexes,—apterous oviparous females and apterous males. Eggs were plentiful under the bark.

It will be noticed that there are two generations of winged forms, one in June and one in August, and that apterous viviparous forms were present during the same time.

Not enough structural difference is found to separate *rileyi* from *americana,* and I am inclined to consider them the same species. Professor Gillette (1909) has made this same suggestion. Figures are given of antennæ and wings of Maine material of *rileyi* and *americana* (figs. 152, 153, 157; 154, 159; 155, 158), for purposes of comparison. The wings are practically identical. The antennal differences might seem more significant except for the fact that Riley's description of the antenna of *americana** fits in every particular more nearly my fall collection of *rileyi* than it does my spring collection of

*See page —— in this bulletin.

americana. The differences in venation cited by Riley will not hold for Maine material, as M has so far been found to be obsolete at base in both *rileyi* and *americana*. Moreover Professor Oestlund records an occasional complete M for *americana* (1887). However, absolutely no biological evidence has been recorded which would serve to link *rileyi* and *americana* and they should undoubtedly be held separate until careful experimental rearing evidence has definitely settled this point. If *americana* should prove to be a synonym of *rileyi* and *rileyi* should prove to be a synonym of *ulmi* of Europe, we should have a curious reversion of *ulmi* Riley of America to *ulmi* Linn. of Europe.

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1890. *Schizoneura rileyi*, Packard. Fifth Rept. U. S. Entom. Com. Wash. Original description of insect quoted.

1897. *Schizoneura rileyi*, Lintner. 13th Report, p. 374. Mere mention.

1901. *Schizoneura rileyi*, Hunter. Aphid of N. A., p. 84. Bibliography in part.

1905. *Schizoneura rileyi*, Felt, N. Y. St. Mus. Memoir *8*: pp. 172, 192. Brief description of work and remedies.

1909. *Schizoneura rileyi*, Gillette. Journal Ec. Ent. Oct. Suggests that it may be same species as *Schizoneura ulmi* (*americana*).

Explanation of Plates.

Fig. 126. *Tetraneura* (*colophoidea*) *graminis*. Gall collected from *Ulmus americana*. Orono, Maine. July 8, 1909.

Fig. 127. *Tetraneura ulmisacculi*. Galls collected from *Ulmus montana* var. *Camperdown pendula*. Orono, Maine, July 6, 1909.

Fig. 128. "*Schizoneura americana*: c, c, leaf showing curl—nat. size: a, winter egg; b, stem-mother; d, winged female; i, her antennae; j, her tarsus; e, true female, ventral view showing solitary egg; g, her tarsus from beneath; f, anus and genital points of male; h, antennae of 4th generation—all enlarged." After Riley.

Fig. 129. *Colopha ulmicola*: a, leaf showing galls from above and beneath—nat. size; b, impregnated egg surrounded by skin of true female; c, newly born young of 2d generation, ventral view; h, its an-

tennae; d, pupa of same, dorsal view; e, winged female; f, her antennae; g, antennae of stem-mother—all enlarged." After Riley.

Fig. 130. *Colopha ulmicola* (*eragrostides*). Specimen taken on *eragrostis* sp. Squaw Creek, Iowa, 9-9-93, by F. A. Sirrine. Note that abnormal left hand antenna has but 5 joints.

Fig. 131. *Colopha ulmicola.* Stem mother from cockscomb gall on cork elm. Collected at Iowa Agr. Col.,7-4-'93, by F. A. Sirrine.

Fig. 132. *Colopha ulmicola* (*eragrostidis*). Apterous viviparous form from root of *Eragrostis.* 10-8-'92. Collected by F. A. Sirrine.

Fig. 133. *Tetraneura graminis* (*colophoidea*). Apterous form *not* stem-mother from galls. See page 209.

Fig. 134. *Tetraneura graminis.* Specimen collected on *Aira caespitosa* in flocculent down by J. T. Monell, October 11, 1876. St. Louis, Mo.

Fig. 135. *Colopha ulmicola* (*eragrostidis*) antenna. Specimen from *Eragrostis frankii* bred in Lab. Iowa Agr. Col. 9-20-'93, by F. A. Sirrine.

Fig. 136. *Colopha ulmicola,* antenna. Specimen from cockscomb galls on cork elm. Collected Iowa Agr. Col. 7-4-'93 by F. A. Sirrine.

Figs. 137, 138. *Tetraneura graminis.* Wings of migrants collected on bark of *Ulmus americana.* Iowa Agric. College 10-4-'92 by F. A. Sirrine.

Fig. 139. *Tetraneura graminis* (*colophoidea*). From slide labeled "*Tetraneura ulmi* from cockscomb gall on *Ulmus americana.*" Specimen collected at Iowa Agr. Col. 6-27-'93 by F. A. Sirrine.

Fig. 140. *Tetraneura graminis.* Antenna of Fig. 134.

Fig. 141. *Tetraneura graminis,* true female. On bark of *Ulmus americana.* Collected at Iowa Agr. Col. 10-4-'92 by F. A. Sirrine.

Fig. 142. *Tetraneura graminis* (*colophoidea*). From slide labeled "*Tetraneura ulmi.* Stem-mother. From cockscomb gall on *Ulmus americana.*" Collected by F. A. Sirrine, 6-27-'93 at Iowa Agricultural Col.

Figs. 143, 144, 145. *Tetraneura graminis.* Larvae on roots of *Leersia virginica.* Collected by F. A. Sirrine at Iowa Agric. College. 9-30-'92.

Fig. 146. *Pemphigus ulmifusus.* Normal venation. Collected at LeRoy, Ill., by J. J. Davis. Fig. 147. Wings. Hind wing normal. Fore wing with M branched near tip. Collected at LeRoy, Ill., by J. J. Davis. Fig. 148. Antenna of migrant. Collected at LeRoy, Ill., by J. J. Davis. Fig. 149. Antenna of pupa, see page 221. Collected in Minnesota by O. W. Oestlund. Slide 125-98. Fig. 150. Gall collected in Minnesota by O. W. Oestlund.

Fig. 151. *Schizoneura americana.* Leaf curl of thickly infested tree causing a bunching or rosette of the leaves. Orono, July 7, 1909. Fig. 152. Fore wing. Fig. 153. Hind wing on smaller scale. Fig. 154. Six-jointed antenna of apterous viviparous form. July 16, 1909. Fig. 155. Antenna of winged form. Fig. 156. Typical "Leaf curl" caused by this insect.

Fig. 157. *Schizoneura rileyi.* Wings. Fig. 158. Antenna of winged form. Fig. 159. Six-jointed antenna of apterous form. Fig. 160. Six-jointed antenna of pupa. Fig. 161. Male. Fig. 162. Female. Same magnification as male. Fig. 163. Woolly colony on young elm. Sept.

23, 1908. Orono. Apterous viviparous forms which give birth to the true sexes.

Fig. 164. *Tetraneura ulmisacculi.* Migrant from gall. Fig. 165. Antenna of foregoing. (a) one of the common variations of VI showing "run-together" annulations. Fig. 166. Antenna of pupa. (a) showing annulations of mature antenna through the pupal skin. Fig. 167. Stem mother. Fig. 168. Antenna of stem mother.

Fig. 169. *Tetraneura graminis* (*colophoidea*). Migrant from gall. Fig. 170. Antenna. Fig. 170 (a) reverse side of IV showing annulations. Fig. 171. Antenna of pupa. Fig. 172. Stem mother. Fig. 173. Antenna. Fig. 174. Apterous viviparous form *not* stem mother frequently found in gall. (See page 209.) Fig. 175. Antenna of foregoing.

Fig. 176. *Colopha ulmicola.* Antenna. II-VI. Slide (157) lent by J. T. Monell. Specimen collected July 2, 1876. St. Louis. "Type or co-type of the genus *Colopha.*"

Fig. 177. Antenna III-VI of specimen collected June 12, 1909, at Lawrence, Kansas. Specimens given by C. P. Gillette.

Fig. 178. *Colopha ulmicola.* Antenna III-VI from specimen collected at LeRoy, Ill., July 10, 1907. Fig. 178 (a) Antenna V-VI of second specimen in same collection showing variation in annulations common to this species. Slides lent by J. J. Davis.

Fig. 179. *Colopha ulmicola.* Antenna I-IV of stem mother removed from gall. Slide (7-4-93. I. A. C.) lent by F. A. Sirrine. Antennal measurements I, 0.035 mm.; II, 0.04 mm.; III, 0.1 mm.; IV, 0.06 mm.

Fig. 180. *Colopha ulmicola* (*eragrostidis*). Antenna. (I-IV) of apterous viviparous form from root of *Eragrostis.* Slide (10-8-92) lent by F. A. Sirrine. Antennal measurements I, 0.025 mm.; II, 0.025 mm.; III, 0.035 mm.; IV, 0.035 mm.

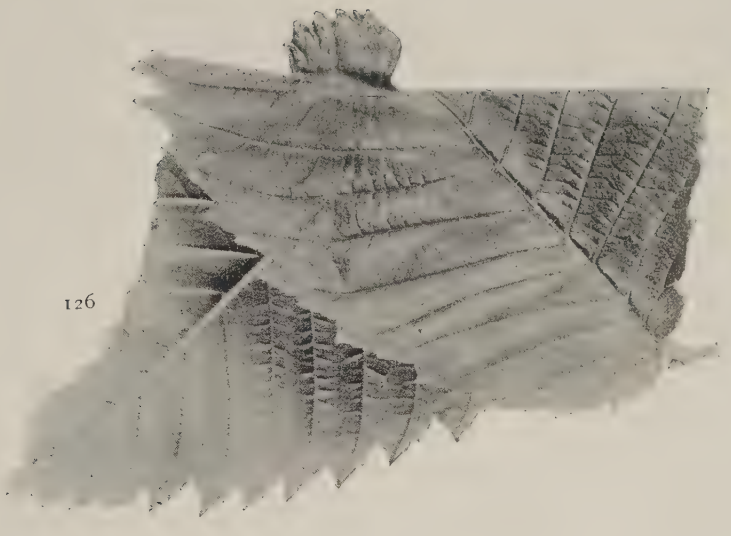
Fig. 181. *Tetrancura graminis,* antenna I-IV of true female, previous to molt. Slide (10-4-'92) lent by F. A. Sirrine. Fig. 182. Distal tip of leg of true female previous to molt, showing capitate hairs. Slide (10-4-'92) lent by F. A. Sirrine. Fig. 183. Antenna I-V of larva on roots of *Leersia virginica.* Slide (I. A. C. 9-30-'92). Slide lent by F. A. Sirrine.

Fig. 184. *Tetraneura graminis* (*colophoidea*). Normal venation.* 1987 fore wings out of 2000 examined had this venation.

Figs. 185-197. *Tetraneura graminis* (*colophoidea*). Abnormal venation. The 13 wings out of 2000 examined which deviated from the normal. In even these 13 cases the wing on one side was normal.

Note: Figures 164 to 172 were drawn by Miss Charlotte M. King. Photographs were taken by Mr. R. Hammond.

*For Comstock-Needham terminology of Aphid wings the reader is referred to *"Homologies of the Wing Veins of Aphididae, Psyllidae, Aleurodidae and Coccidae."* Annals Entomological Society of America. Vol. II, No. 2.



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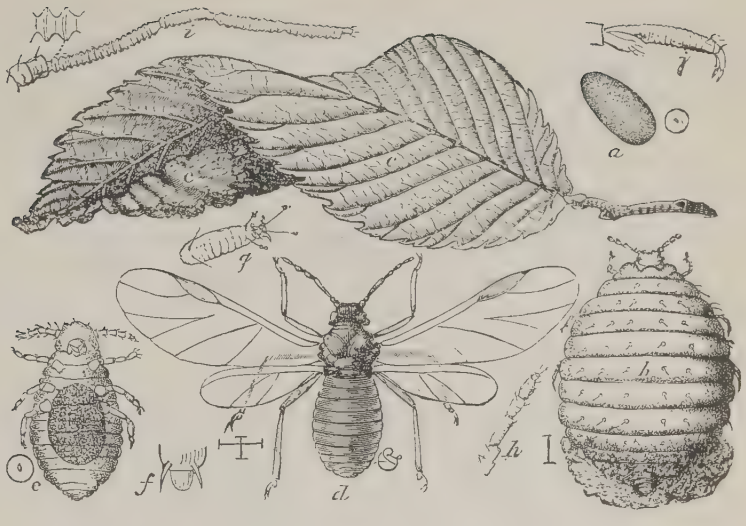

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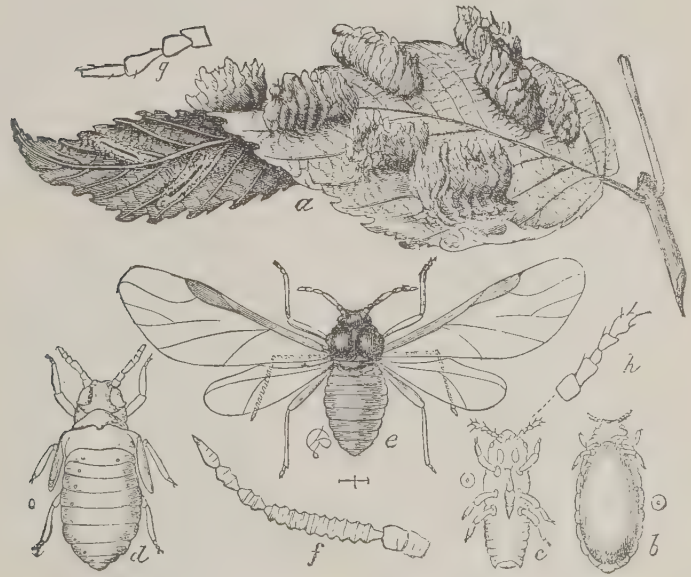

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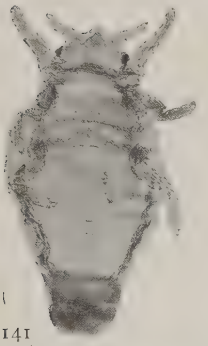

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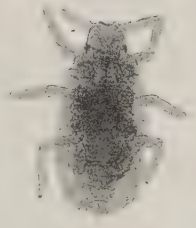

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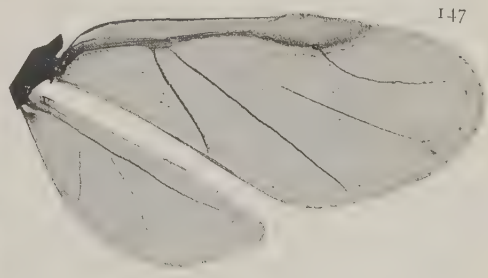
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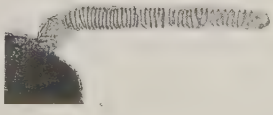
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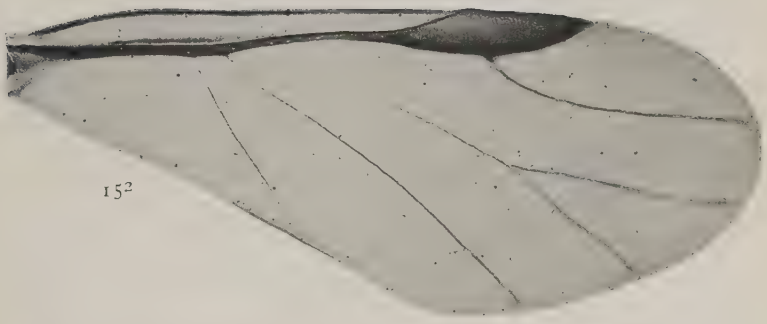

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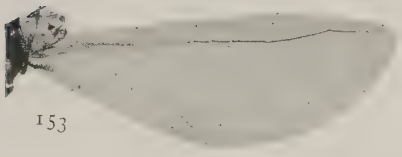

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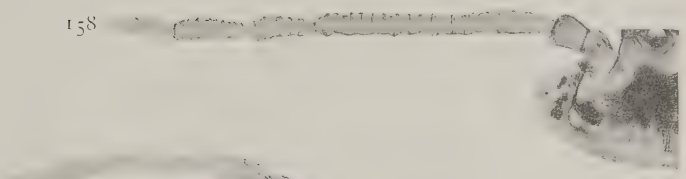

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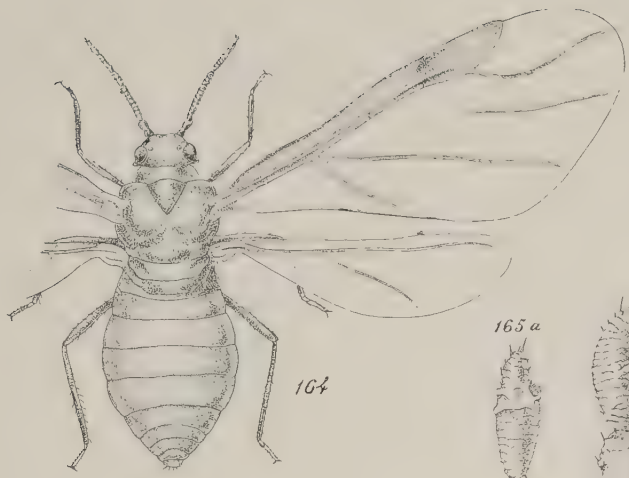
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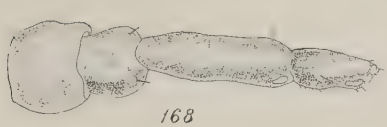
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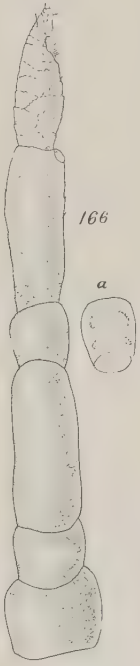
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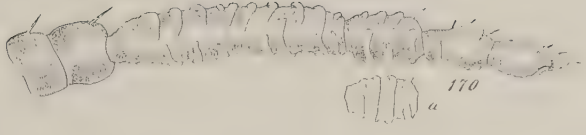
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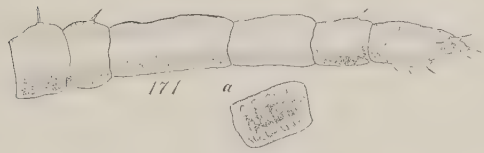
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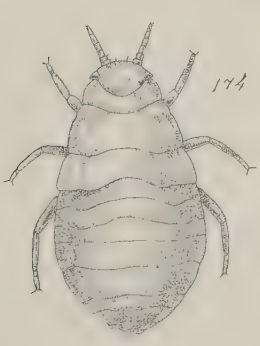
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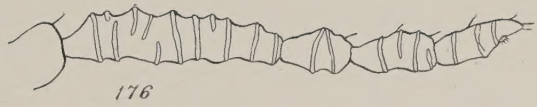

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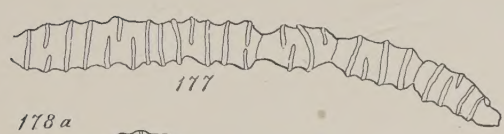

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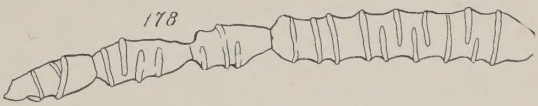

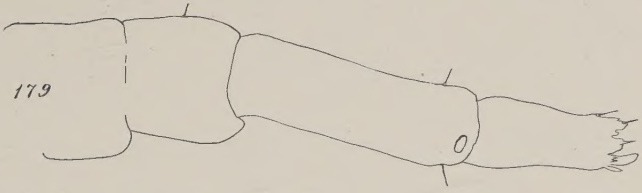

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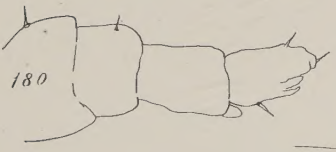

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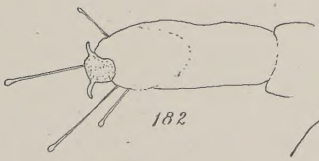

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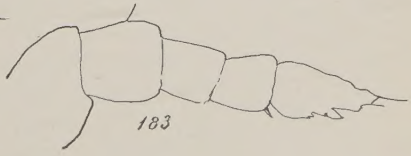

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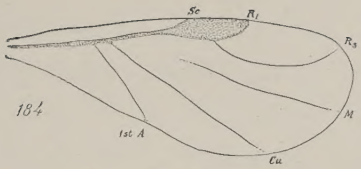

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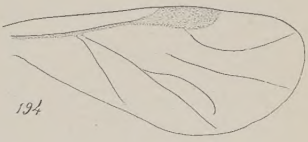

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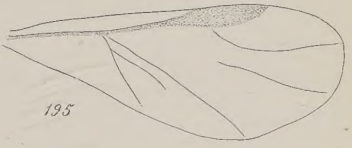

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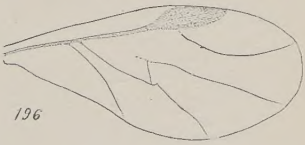

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